THE RECOVERY OF SODIUM HYDROXIDE FROM COTTON SCOURING EFFLUENTS

by

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APPENDICES

Note

Some tabulated data and spreadsheets which are presented here were originally set up using international software in which decimal points are used in place of decimal commas.

APPENDIX 1

CANDIDATE'S PUBLICATIONS LIST

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Directly Related to Dissertation

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3) C.A. BUCKLEY and **A.E. SIMPSON**, Effluent Treatment, Australian Patent No. 590,852, 15 June 1987.

4) C.A. BUCKLEY and **A.E. SIMPSON**, Effluent Treatment, Japanese Patent No. 62,155646, 24 June 1987.

5) C.A. BUCKLEY and **A.E. SIMPSON**, Effluent Treatment, United States of America Patent No. 4752363, 21 June 1987.

6) C.A. BUCKLEY and **A.E. SIMPSON**, Effluent Treatment, German Patent No. 87305644.4, 27 June 1990.

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APPENDIX 2

MODIFICATIONS OF RINSING EQUATIONS FOR FOUR-BOWL COUNTER-CURRENT RINSING RANGE

With reference to Figure 4.11:

$$
\begin{aligned}
C_0m_0 + f_2S_2 &= C_1m_1 + f_1S_1 \\
C_1m_1 + f_3S_3 &= C_2m_2 + f_2S_2 \\
C_2m_2 + f_4S_4 &= C_3m_3 + f_3S_3 \\
C_3m_3 + f_5S_5 &= C_4m_4 + f_4S_4
\end{aligned}
$$

equation A2.1

In addition,

$$
\begin{aligned}
f_4 &= f_5 + m_3 - m_4 \\
f_3 &= f_4 + m_2 - m_4 \\
f_2 &= f_3 + m_1 - m_4 \\
f_1 &= f_2 + m_0 - m_4
\end{aligned}
$$

equation A2.2

and

$$S_i = \frac{kC_{i-1} - C_i}{k-1}$$

equation A2.3

Substituting equation A2.3 into A2.1 gives:

$$
\begin{aligned}
C_0m_0 + f_2\frac{kC_1 - C_2}{k-1} &= C_1m_1 + f_1\frac{kC_0 - C_1}{k-1} \\
C_1m_1 + f_3\frac{kC_2 - C_3}{k-1} &= C_2m_2 + f_2\frac{kC_1 - C_2}{k-1} \\
C_2m_2 + f_4\frac{kC_3 - C_4}{k-1} &= C_3m_3 + f_3\frac{kC_2 - C_3}{k-1} \\
C_3m_3 + f_5S_5 &= C_4m_4 + f_4\frac{kC_3 - C_4}{k-1}
\end{aligned}
$$

equation A2.4

Multiplying equation A2.4 through (k-1) and collecting and rearranging terms gives:

$$
\begin{aligned}
&C_1(m_1k - m_1 - f_1 - f_2k) + C_2(f_2) = C_0(- f_1k + m_0k - m_0) \\
&C_1(m_1k - m_1 - f_2k) + C_2(f_3k - m_2k + m_2 + f_2) + C_3(- f_3) = 0 \\
&C_2(m_2k - m_2 - f_3k) + C_3(f_4k - m_3k + m_3 + f_3) + C_4(- f_4) = 0 \\
&C_3(m_3k - m_3 - f_4k) + C_4(- m_4k + m_4 + f_4) = - f_5S_5(k-1)
\end{aligned}
$$

equation A2.5

The matrix solution becomes:

$$
\begin{bmatrix}
-kf_2-a_1 & f_2 & 0 & 0 \\
b_1 & kf_3+a_2 & -f_3 & 0 \\
0 & b_2 & kf_4+a_3 & -f_4 \\
0 & 0 & b_3 & a_4
\end{bmatrix}
\begin{bmatrix}
C_1 \\ C_2 \\ C_3 \\ C_4
\end{bmatrix}
=
\begin{bmatrix}
C_0b_0 \\ 0 \\ 0 \\ -f_5S_5(k-1)
\end{bmatrix}
$$

equation A2.6

where $a_n = - m_nk + m_n + f_n$

$b_n = m_nk - m_n - f_{n+1}k$

APPENDIX 3

DEPENDENCE OF RINSING PERFORMANCE ON NIP EXPRESSION COMBINATION AND SPECIFIC WATER USE IN A FOUR-BOWL COUNTER-CURRENT RINSE RANGE

Cloth speed	780 kg/h
C_0	50 g/l NaOH (28,75 g/l Na)
k	0,15
S_5	0 g/l Na

Case 1
m_0 to m_4 = 0,8 l/kg

f5	c1	c2	c3	c4	%removal	s1	cloth mass	effluent mass
0.000	28.750	28.750	28.750	28.750	0.000	28.750	23.000	0.000
0.500	26.746	23.721	19.153	12.254	57.377	26.393	9.803	13.960
1.000	20.871	14.332	8.904	4.399	84.699	19.481	3.519	19.481
1.500	16.479	9.075	4.608	1.913	93.346	14.313	1.530	21.470
2.000	13.741	6.387	2.784	1.018	96.459	11.093	0.814	22.186
2.500	11.962	4.878	1.888	0.626	97.823	9.000	0.501	22.499
3.000	10.732	3.946	1.390	0.427	98.515	7.553	0.342	22.659
3.500	9.387	3.326	1.084	0.313	98.911	6.500	0.250	22.750
4.000	9.159	2.890	0.884	0.242	99.158	5.702	0.194	22.807
4.500	8.628	2.568	0.744	0.195	99.322	5.077	0.156	22.844
5.000	8.201	2.323	0.642	0.162	99.437	4.574	0.130	22.871
5.500	7.850	2.131	0.566	0.138	99.520	4.162	0.110	22.890
6.000	7.557	1.976	0.507	0.120	99.583	3.817	0.096	22.904
6.500	7.309	1.850	0.460	0.106	99.631	3.525	0.085	22.915
7.000	7.096	1.745	0.422	0.095	99.670	3.275	0.076	22.924
7.500	6.911	1.656	0.391	0.086	99.701	3.057	0.069	22.931

Case 2
m_0 to m_4 = 0,65 l/kg

f5	c1	c2	c3	c4	%removal	s1	cloth mass	effluent mass
0.000	28.750	28.750	28.750	28.750	0.000	28.750	18.688	0.000
0.500	25.455	21.320	16.130	9.617	66.550	24.873	7.694	12.437
1.000	18.588	11.450	6.435	2.912	89.871	16.795	2.330	16.795
1.500	14.455	7.045	3.025	1.214	95.777	11.932	0.971	17.898
2.000	12.076	4.968	1.939	0.648	97.746	9.133	0.518	18.267
2.500	10.577	3.843	1.333	0.405	98.591	7.370	0.324	18.424
3.000	9.555	3.141	0.998	0.282	99.019	6.168	0.226	18.504
3.500	8.818	2.681	0.792	0.211	99.266	5.300	0.169	18.551
4.000	8.261	2.357	0.656	0.166	99.423	4.645	0.133	18.580
4.500	7.826	2.118	0.561	0.136	99.527	4.133	0.109	18.599
5.000	7.477	1.935	0.491	0.115	99.600	3.723	0.092	18.613
5.500	7.191	1.791	0.439	0.100	99.652	3.386	0.080	18.623
6.000	6.952	1.675	0.397	0.088	99.694	3.105	0.070	18.630
6.500	6.750	1.579	0.364	0.079	99.725	2.867	0.063	18.636
7.000	6.576	1.500	0.338	0.072	99.750	2.663	0.058	18.641
7.500	6.426	1.432	0.316	0.066	99.770	2.486	0.053	18.645

Case 3
m_0 to m_4 = 0,5 l/kg

f5	c1	c2	c3	c4	%removal	s1	cloth mass	effluent mass
0.000	28.750	28.750	28.750	28.750	0.000	28.750	18.688	0.000
0.500	23.196	17.642	12.088	6.534	77.273	22.216	5.227	11.108
1.000	15.825	8.393	4.119	1.662	94.219	13.544	1.330	13.544
1.500	12.265	5.121	2.025	0.684	97.621	9.355	0.547	14.033
2.000	10.342	3.670	1.251	0.374	98.699	7.094	0.299	14.188
2.500	9.159	2.890	0.884	0.242	99.158	5.702	0.194	14.254
3.000	8.361	2.414	0.679	0.174	99.395	4.763	0.139	14.288
3.500	7.787	2.097	0.553	0.134	99.534	4.088	0.107	14.308
4.000	7.356	1.873	0.469	0.109	99.621	3.580	0.087	14.321
4.500	7.091	1.707	0.409	0.091	99.683	3.184	0.073	14.329
5.000	6.750	1.579	0.364	0.079	99.725	2.867	0.063	14.336
5.500	6.529	1.478	0.331	0.070	99.757	2.607	0.056	14.340
6.000	6.345	1.397	0.304	0.063	99.781	2.391	0.050	14.344
6.500	6.189	1.329	0.283	0.057	99.802	2.207	0.046	14.346
7.000	6.055	1.273	0.265	0.053	99.816	2.050	0.042	14.349
7.500	5.939	1.225	0.250	0.049	99.830	1.913	0.039	14.351

Case 4
m_0 and m_4 = 0,5 l/kg; m_1 to m_3 = 0,8 l/kg

f5	c1	c2	c3	c4	%removal	s1	cloth mass	effluent mass
0.000	28.750	28.750	28.750	28.750	0.000	28.750	14.375	0.000
0.500	21.654	17.219	12.784	8.348	70.963	20.402	4.174	10.201
1.000	15.357	9.433	5.446	2.763	90.390	12.994	1.382	12.994
1.500	12.105	6.094	2.922	1.248	95.659	9.168	0.624	13.751
2.000	10.274	4.450	1.854	0.697	97.576	7.014	0.349	14.027
2.500	9.124	3.516	1.313	0.448	98.442	5.661	0.224	14.151
3.000	8.341	2.929	1.002	0.316	98.901	4.739	0.158	14.218
3.500	7.775	2.531	0.806	0.238	99.172	4.074	0.119	14.257
4.000	7.347	2.245	0.673	0.189	99.343	3.570	0.095	14.280
4.500	7.013	2.032	0.579	0.155	99.461	3.177	0.078	14.297
5.000	6.745	1.867	0.509	0.131	99.544	2.862	0.066	14.309
5.500	6.525	1.736	0.455	0.113	99.607	2.603	0.057	14.316
6.000	6.342	1.629	0.413	0.100	99.652	2.388	0.050	14.326
6.500	6.186	1.541	0.380	0.089	99.690	2.204	0.045	14.327
7.000	6.053	1.467	0.352	0.081	99.718	2.048	0.041	14.334
7.500	5.937	1.404	0.329	0.074	99.743	1.911	0.037	14.334

Case 5
m_0 to m_3 = 0,8 l/kg; m_4 = 0,5 l/kg

f5	c1	c2	c3	c4	%removal	s1	cloth mass	effluent mass
0.000	28.750	28.750	28.750	28.750	37.500	28.750	14.375	8.625
0.500	23.863	18.975	14.088	9.200	80.000	23.001	4.600	18.400
1.000	18.276	11.226	6.481	3.288	92.852	16.428	1.644	21.356
1.500	14.813	7.458	3,576	1.527	96.680	12.354	0.764	22.236
2.000	12.654	5.480	2.284	0.859	98.133	9.814	0.430	22.571
2.500	11.211	4.321	1.614	0.550	98.804	8.116	0.275	22.724
3.000	10.187	3.577	1.224	0.386	99.161	6.911	0.193	22.807
3.500	9.425	3.068	0.977	0.289	99.372	6.015	0.145	22.856
4.000	8.837	2.700	0.810	0.227	99.507	5.323	0.114	22.889
4.500	8.639	2.425	0.691	0.185	99.598	5.090	0.093	24.432
5.000	7.989	2.211	0.603	0.155	99.663	4.325	0.078	22.924
5.500	7.673	2.041	0.536	0.133	99.711	3.954	0.067	22.930
6.000	7.408	1.903	0.483	0.117	99.746	3.642	0.059	22.943
6.500	7.181	1.789	0.441	0.104	99.774	3.375	0.052	22.948
7.000	6.985	1.693	0.406	0.093	99.798	3.144	0.047	22.952
7.500	6.814	1.612	0.378	0.085	99.815	2.943	0.043	22.955

Case 6
m_0 = 0,5 l/kg; m_1 to m_4 = 0,8 l/kg

f5	c1	c2	c3	c4	%removal	s1	cloth mass	effluent mass
0.000	28.750	28.750	28.750	28.750	-60.000	28.750	23.000	-8.625
0.500	25.571	22.679	18.311	11.716	34.798	25.010	9.373	5.002
1.000	18.068	12.407	7.708	3.808	78.808	16.183	3.046	11.328
1.500	13.600	7.490	3.803	1.579	91.213	10.926	1.263	13.112
2.000	11.169	5.192	2.263	0.827	95.398	8.066	0.662	13.713
2.500	9.709	.3.595	1.532	0.508	97.173	6.349	0.406	13.967
3.000	8.750	3.217	1.133	0.348	98.063	5.221	0.278	14.096
3.500	8.076	2.731	0.890	0.257	98.570	4.428	0.206	14.168
4.000	7.578	2.391	0.731	0.200	98.887	3.842	0.160	14.215
4.500	7.195	2.142	0.620	0.162	99.098	3.391	0.130	14.243
5.000	6.893	1.953	0.540	0.136	99.243	3.036	0.109	14.269
5.500	6.647	1.804	0.479	0.117	99.349	2.746	0.094	14.282
6.000	6.444	1.685	0.432	0.102	99.432	2.508	0.082	14.294
6.500	6.237	1.588	0.395	0.091	99.494	2.264	0.073	14.038
7.000	6.128	1.506	0.364	0.082	99.544	2.136	0.066	14.310
7.500	6.002	1.438	0.339	0.075	99.583	1.988	0.060	14.311

APPENDIX 4

WASHING CHARACTERISTICS AND PERFORMANCE DEPENDENCE ON WASH WATER CONCENTRATION FOR THREE DRAG-OUT COMBINATIONS IN A FOUR-BOWL COUNTER-CURRENT RINSE RANGE

Cloth speed	780 kg/h
C_0	50 g/l NaOH (28,75 g/l Na)
k	0,15
f	1,50 l/kg fabric

Case 1
m_0 to m_4 = 0,5 l/kg

s5	c1	c2	c3	c4	%removal	s1	cloth mass	effluent mass
0.00	12.26	5.12	2.03	0.68	97.63	9.35	0.34	14.03
1.00	12.84	5.94	2.95	1.66	94.23	10.03	0.83	15.05
2.00	13.41	6.76	3.88	2.64	90.82	10.70	1.32	16.05
3.00	13.98	7.59	4.81	3.61	87.44	11.37	1.81	17.06
4.00	14.56	8.41	5.74	4.59	84.03	12.06	2.30	18.08
5.00	15.13	9.23	6.67	5.56	80.66	12.73	2.78	19.09
6.00	15.71	10.05	7.60	6.54	77.25	13.41	3.27	20.11

Case 2
m_0 to m_4 = 0,65 l/kg

s5	c1	c2	c3	c4	%removal	s1	cloth mass	effluent mass
0.00	12.10	6.09	2.92	1.25	95.65	9.16	0.63	13.74
1.00	12.68	6.88	3.82	2.20	92.35	9.84	1.10	14.77
2.00	13.26	7.67	4.72	3.16	89.01	10.53	1.58	15.79
3.00	13.84	8.46	5.62	4.12	85.67	11.21	2.06	16.81
4.00	14.42	9.25	6.52	5.07	82.37	11.89	2.54	17.84
5.00	15.00	10.03	7.41	6.03	79.03	12.57	3.02	18.86
6.00	15.58	10.82	8.31	6.99	75.69	13.26	3.50	19.88

Case 3
m_0 to m_4 = 0,5 l/kg

s5	c1	c2	c3	c4	%removal	s1	cloth mass	effluent mass
0.00	14.81	7.46	3.58	1.53	96.67	12.35	0.77	22.23
1.00	15.30	8.20	4.45	2.47	94.63	12.93	1.24	23.27
2.00	15.78	8.94	5.33	3.42	92.57	13.49	1.71	24.28
3.00	16.27	9.68	6.20	4.37	90.50	14.07	2.19	25.32
4.00	16.75	10.42	7.08	5.31	88.46	14.63	2.66	26.34
5.00	17.24	11.16	7.95	6.26	86.39	15.21	3.13	27.38
6.00	17.72	11.90	8.83	7.21	84.33	15.77	3.61	28.39

APPENDIX 5

COMMENTS ON ANALYTICAL METHODS AND OPERATIONAL PROCEDURES FOR INDIVIDUAL PILOT PLANT EXPERIMENTS

Table A5-1 summarises the conditions of electrolysis for each experiment. The subsequent script summarises selected analytical procedures and examines variations in the operational procedures for individual experiments.

Table A5-1
Summary of Conditions of Electrolysis for Each Experiment

Experiment Number	Stage	Anolyte	Initial Anolyte Concentration (g/l Na^+)	Initial Catholyte Concentration (g/l NaOH)	Volume Raw Effluent/ Nanofiltrate (litres)	Total Faradays Consumed (F)
1	carbonation	Na_2CO_3	31	85	67	16
	electrolysis A	nanofiltrate	2	118	25	1,0
	electrolysis B	nanofiltrate	2	122	32	1,3
2	carbonation	Na_2CO_3	45	55	75	51
	electrolysis A	nanofiltrate	6	85	20	3,8
	electrolysis B	nanofiltrate	6	92	20	3,0
3	carbonation	Na_2CO_3	45	85	285	50
	electrolysis A	nanofiltrate	12	121	25	7,2
	electrolysis B	nanofiltrate	12	131	25	6,6
4	carbonation	Na_2CO_3	30	122	160	36
	electrolysis A	nanofiltrate	7	89	30	7,8
	electrolysis B	nanofiltrate	7	108	30	8,1
	electrolysis C	nanofiltrate	7	107	30	6,5
5	carbonation	$Na_2CO_3/NaHCO_3$	32	92	120	36
	electrolysis A	nanofiltrate	5	99	30	4,6
	electrolysis B	nanofiltrate	4	90	30	3,8
	electrolysis C	nanofiltrate	6	87	20	2,8
6	carbonation	$Na_2CO_3/NaHCO_3$	29	106	160	32
7	carbonation	$Na_2CO_3/NaHCO_3$	29	50	120	41
	electrolysis A	nanofiltrate	5	162	25	5,3
	electrolysis B	nanofiltrate	6	151	25	4,6
	electrolysis C	nanofiltrate	7	111	25	4,9
8	carbonation	$NaHCO_3$	29	94	120	23
	electrolysis A	nanofiltrate	8	160	25	8,1
	electrolysis B	nanofiltrate	5	148	25	5,1
	electrolysis C	nanofiltrate	5	110	35	6,9
9	carbonation	$NaHCO_3$	28	104	120	25
	electrolysis A	nanofiltrate	8	172	30	8,3
	electrolysis B	nanofiltrate	6	126	25	7,4
10	carbonation	$NaHCO_3$	28	87	120	34
	electrolysis A	nanofiltrate	8	167	25	8,9
	electrolysis B	nanofiltrate	8	143	25	8,0
11	carbonation	$NaHCO_3$	30	104	160	45
	electrolysis A	nanofiltrate	7	148	35	10
	electrolysis B	nanofiltrate	7	153	35	11
	electrolysis C	nanofiltrate	7	111	35	9,4
12	electrolysis A	nanofiltrate	7	113	35	12
	electrolysis B	nanofiltrate	6	113	40	9,1

Table A5-1 c/t

Experiment Number	Stage	Anolyte	Initial Anolyte Concentration (g/l Na^+)	Initial Catholyte Concentration (g/l NaOH)	Volume Raw Effluent/ Nanofiltrate (litres)	Total Faradays Consumed (F)
13	carbonation	Na_2CO_3/$NaHCO_3$	31	104	50	33
	electrolysis A	nanofiltrate	5	111	30	7,0
	electrolysis B	nanofiltrate	8	98	30	9,7
	electrolysis C	nanofiltrate	8	100	30	11
14	electrolysis A	nanofiltrate	4	108	35	6,9
	electrolysis B	nanofiltrate	5	96	30	7,0
	electrolysis C	nanofiltrate	6	87	35	7,6
15	carbonation	$NaHCO_3$	18	88	120	23
	electrolysis A	nanofiltrate	5	87	30	5,8
	electrolysis B	nanofiltrate	5	70	30	5,5
	electrolysis C	nanofiltrate	5	78	24	4,3
16	electrolysis A	nanofiltrate	4	90	30	4,1
	electrolysis B	nanofiltrate	5	65	30	4,4
17	carbonation	$NaHCO_3$	21	91	120	17
18	carbonation	$NaHCO_3$	26	69	120	37
	electrolysis A	nanofiltrate	41	62	40	46
	electrolysis B	nanofiltrate	48	94	43	41
19	electrolysis A	nanofiltrate	39	56	30	30
	electrolysis B	nanofiltrate	37	85	20	42
20	carbonation	$NaHCO_3$	35	75	60	30
	electrolysis A	nanofiltrate	26	107	20	10
	electrolysis B	nanofiltrate	26	172	18	15
21	electrolysis A	nanofiltrate	16	110	13	11
	electrolysis B	nanofiltrate	21	136	14	15
	electrolysis C	nanofiltrate	15	160	13	18

Analytical Procedures

The procedures and methods used for analytical determination of the chemical parameters are summarised below:

Total Carbon, Total Inorganic Carbon and Total Organic Carbon (TC, TIC, TOC)

Total carbon and total inorganic carbon concentrations were determined by the combustion of aliquots of sample in the presence of oxygen at 900 °C and 150 °C respectively in a Beckman TC analyser. The instrument was fitted with an infra-red detector to measure the carbon dioxide combustion product. Organic carbon was determined by the difference. The analytical range of the detector was 0 to 600 mg/l for TC and 0 to 120 mg/l for TIC.

Chemical Oxygen Demand

The standard wet chemistry method, involving chemical oxidation of oxidisable material by dichromate, was used.

Metal Ions

Sodium, calcium and magnesium concentrations were determined using atomic adsorption spectroscopy. The calcium and magnesium standards were spiked with sodium salts to compensate for interferences by sodium. Analytical ranges were 0 to 400 mg/l for Na, 0 to 50 mg/l for Ca, and 0 to 50 mg/l Mg.

Hydroxide, Carbonate and Bicarbonate

These anion species were determined by standard alkalinity titrations to two end points: pH 8,3 and pH 4,0 using HCl. Standard analytical equations were used to compute the concentrations of hydroxide, carbonate and bicarbonate ions from the titration data.

Operation Procedures

Experiment 1

1) The initial cross-flow microfiltration tube length of 30 m was reduced to 20 m after experiment 1, because velocities down the tube could not be maintained at acceptable levels.
2) The effluent used in experiment 1 was very dilute by comparison to the normal concentration.
3) Cross-flow microfiltration evaporative loss was 2 litres (3 %).

Experiment 2

1) Cross-flow microfiltration evaporative loss was 15 litre (20 %); nanofiltration evaporative loss was 2 litre (4 %).
2) Gas line from anolyte system to absorption unit was kinked, inhibiting gas flow.

Experiment 3

1) Cross-flow microfiltration evaporative loss was 10 litre (13 %).
2) 180 litres of nanofiltrate was collected for laboratory fouling tests using Nafion 324.

Experiment 4

1) Cross-flow microfiltration evaporative loss was 40 litre (25 %); nanofiltration evaporative loss was 4 litre (4 %).
2) During nanofiltration, the module housing burst and approximately 60 l of feed was lost. The final feed sample was viscous and it was considered probable that physical blockage of the membrane occurred. This was evidenced by the reduction of nanofilter fluxes during experiment 4 to less than half of those previously recorded.
3) The anolyte used to provide supplementary carbon dioxide for carbonation for experiments 1 to 3 was sodium carbonate. From experiment 4 onwards, the solution was changed to a combination of sodium carbonate and bicarbonate to facilitate release of gas during electrolysis.

Experiment 5

1) A pipe burst during cross-flow microfiltration resulted in the loss of approximately 10 litres of feed.
2) Cross-flow microfiltration evaporative loss was 5 litre (4 %); nanofiltration evaporative loss was 22 litre (19 %).

Experiment 6

Only 40 litres of cross-flow microfiltrate was collected. Modifications were made to the cross-flow microfiltration rig and the experiment was abandoned. The tube was shortened from 20 m to 12 m. The reject flow rate was measured at 1,88 m/sec (P_{in} = 200 kPa, P_{out} = 100 kPa). A clean water flux was 160 l/m^{2}h (P_{in} = 160 kPa, P_{out} = 100 kPa, bypass closed, reject flow velocity 0,68 m/sec).

Experiment 7

1) Because of problems with the cross-flow microfilter, most of the nanofiltration feed was not pretreated by cross-flow microfiltration.
2) Approximately 20 litres of anolyte was lost because of a leak in the pump casing.
3) Nanofiltration evaporative loss was 20 litre (20 %).

Experiment 8

1) Cross-flow microfiltration evaporative loss was 35 litre (29 %); nanofiltration evaporative loss was 5 litre (5 %).

2) From experiment 8 onwards, the anolyte used to provide supplementary carbon dioxide for carbonation was changed from a combination of sodium carbonate and bicarbonate, to a sodium bicarbonate solution to facilitate most rapid release of carbon dioxide during electrolysis.

Experiment 9

1) Cross-flow microfiltration evaporative loss was 35 litre (29 %); nanofiltration evaporative loss was 10 litre (13 %).
2) From experiment 9 onwards, the filtration aid during cross-flow microfiltration was changed from diatomaceous earth (15 ml/batch) to a mixture of limestone (25 ml) and diatomaceous earth (2 ml).
3) From experiment 9 onwards, the voltage drops across each section of each cell (anode-membrane; membrane; cathode-membrane, anode-cathode) were monitored. Previously, only the volt drop across one cell was recorded.

Experiment 10

During cross-flow microfiltration, a total of 50 litres (42 %) of feed was lost as a result of evaporation and a leak in the gland of the pump.

Experiment 11

Cross-flow microfiltration evaporative loss was 20 litre (17 %); nanofiltration evaporative loss was 20 litre (13 %).

Experiment 12

1) No carbonation using prepared solutions was required, since sufficient carbon dioxide was generated during experiment 11 to neutralise the effluent.
2) Cross-flow microfiltration evaporative loss was 25 litre (29 %).
3) During experiment 12A, the relationship between electrolyte flows and cell voltage was investigated to determine gas blinding effects. Current densities were held constant at 600 and 1 000 A/m^2.
4) The anolyte pump was overheating.

Experiment 13

1) A leak in the catholyte pump during experiment 13B resulted in the loss of approximately 5 litres of NaOH.
2) Nanofiltration evaporative loss was 25 litres (20 %).

Experiment 14

1) No carbonation was required since sufficient carbon dioxide was generated during experiment 13 to carbonate the effluent.
2) Cross-flow microfiltration evaporative loss was 30 litre (20 %); nanofiltration evaporative loss was 17 litre (15 %).
3) The catholyte pump was leaking during experiment 14A.

Experiment 15

Cross-flow microfiltration evaporative loss was 15 litre (13 %); nanofiltration evaporative loss was 9 litre (9 %).

Experiment 16

1) Nanofiltration evaporative loss was 10 litre (9 %).
2) The manifolds to the cell stack were modified to allow parallel flow of electrolyte through each cell, instead of series flow.

Experiment 17

1) The experiment was abandoned for the Christmas shutdown after the cross-flow microfiltration stage.
2) The nanofiltration fluxes had been very low, and an attempt was made to clean the membrane. The cleaning procedures used are listed in Table A5-2.

Table A5-2
List of Cleaning Procedures

Cleaning Solution	Recycle Time (h)	Deionised Water Flux After Cleaning (l/m^2h at 1,6 MPa)
10 g/l NaOH + 5 g/l Kieralon[1]	0,5	6,7
0,1 % H_3PO_4	0,5	8,2
boric acid	0,5	8,2
10 g/l NaOH + 5 g/l Kieralon + EDTA	2,0	6,7
0,1 % H_3PO_4	0,5	6,7
distilled water	2,0	7,3
Kieralon + warm water (40 °C)	0,5	-
warm water	0,3	14,0

Note 1 - detergent used in scouring

Failing significant flux improvement, the nanofiltration membrane was replaced with a membrane which had been used in previous trials at a different factory. The deionised water flux was 161 l/m^2h at 1,6 MPa.

3) After experiment 17, the anode from the first cell was sent back to the manufacturers to examine the condition of the precious metal surface, including the thickness of the oxide layer. Visible signs of surface wear were noted in certain areas where the anode had contacted the membrane. However, in areas where the membrane had not been in contact with the anode, little wear was detected.
4) On dismantling the cell stack after experiment 17, a white scale was observed to have deposited on the anode and cathode surfaces, and on the conducting plates. One cell was then operated using pure sodium bicarbonate and uncleaned cell components. All the connecting surfaces of the electrodes and conducting plate were then sanded to remove deposit. The experiment was repeated using sodium bicarbonate.
5) After experiment 17, an investigation was carried out to compare the performance of the coated anodes with other anodes. The manifolds were replaced to allow for single cell operation. The performance of the cell was monitored using a combination of stainless steel anode and cathode.

Experiment 18

1) The cell manifolds were modified to allow for two-cell operation using the coated anodes.
2) Up until experiment 18, the feed to the absorption column had been unmodified scouring effluent. During experiment 18, it was hoped to investigate the performance of the treatment sequence against scouring effluent which was spiked to simulate a background concentration rinse water recycle system (containing sodium bicarbonate). 125 g/l of commercial grade sodium bicarbonate was added to the feed to the absorption column during experiments 18 and 19.
3) During experiment 18, the impeller of the pump feeding the absorption column broke from the shaft and was repaired.
4) After cross-flow microfiltration, a white powder precipitated in samples and was assumed to be sodium bicarbonate.
5) The *new* nanofiltration membrane was used, but after the first pass all colour was not removed because of incorrect positioning of the membrane in the module holder.
6) Until experiment 18, a voltage/current relationship was determined at the beginning and end of each experiment. During experiment 18 and 19, the relationship was determined at regular intervals to allow data to be collected which would enable limiting current densities to be calculated at various anolyte concentrations.
7) Until experiment 18, all electrolysis experiments were conducted continuously from beginning to end. Because of the high sodium concentrations in the anolyte during experiments 18 and 19, depletion could not be achieved in one day. As a result, each experiment was run over several days.

8) After experiment 18B, the two PVC ball valves on the anolyte and catholyte tanks were replaced. Leaks had occurred resulting from the elongation of the ball inside the valves under the prolonged conditions of elevated temperature.

Experiment 19

1) No separate carbonation stage was required, since the generation of gas from experiment 18 had been sufficient to achieve the required pH reduction.
2) A pipe burst during cross-flow microfiltration resulted in the loss of 30 litres of feed.
3) The *new* nanofiltration membrane was tested for rejection of a reactive dyestuff. Rejections were incomplete, and it was assumed that the membrane was damaged. The original membrane was reinstalled despite initial fluxes being low. Subsequent investigation revealed that the pH of the feed was 9,7 and not below 8,6 as required. After reducing the feed pH using nitric acid, fluxes were increased eightfold.
4) The electro-membrane from the second cell was removed and inspected. One small pin-hole was visible through the polymer layers between the Teflon reinforcement, and the membrane turned brittle on drying. It bulged towards the anode side, around the spacer mesh and between the frame and spacer mesh. Markings on the electrodes suggested that the membrane had been in contact with both electrodes at various times. Where the membrane had not contacted the electrodes (approximately 60 % of the total electrode area), there was a visible deposit of scale on the anode surface of the membrane, while the polymer structure between the Teflon threads bulged toward the anode side. In areas where the membrane was not in contact with the electrodes, no deposit or bulging was evident.
5) The spacer mesh was slightly deformed, bulging toward the anolyte.
6) For experiment 19B, a nickel anode was installed. At pH 6,9 a pale green precipitate was evident in the anolyte, and at pH 6,2, the precipitate was black. After 11,1 F of electricity had been passed, the cell was opened and the nickel anode was noted to be coated with a black deposit. Experiment 19B was continued over 3 days. Therafter, the anolyte compartment had to be thoruoghly flushed to remove all signs of the precipitate.

Experiment 20

1) During the carbonation stage, the anolyte volume decreased initially from 20 litres to 11 litres at 18,1 F, while the catholyte volume increased from 32 litres initially to 43 litres during the same period. Thereafter, the phenomenon reversed itself, with the anolyte volume suddenly increasing to 18 litres and the catholyte volume decreasing to 32 litres during the subsequent 11 F.
2) A pale green precipitate was evident at pH 8,0, while a black precipitate formed at pH 7,6.

Experiment 21

1) A pale green precipitate was evident at pH 7,8, while a black precipitate formed at pH 7,3.
2) The experiment was discontinued after 17,7 F because too little anolyte remained to enable recirculation of the electrolyte through the cell.

APPENDIX 6

PILOT PLANT INVESTIGATIONS

This Appendix contains:

Analytical and Physical Data for Each Stage of Each Experiment

Tables in this Appendix labelled *A5 Table 1 to 92* have been reproduced from Appendix 5 of a report entitled *Pilot plant results for the recovery of sodium hydroxide from pretreated scour effluent at Da Gama Textiles, King Williams Town, April 1987* which forms App 8, Part 3(b) of final report to the WRC, Pollution Reserach Group (1989).

Calculations of Current Efficiency

Tables in this Appendix labelled *A7 Table 1 to 56* have been reproduced from Appendix 7 of a report entitled *Pilot plant results for the recovery of sodium hydroxide from pretreated scour effluent at Da Gama Textiles, King Williams Town, April 1987* which forms App 8, Part 3(b) of final report to the WRC, Pollution Reserach Group (1989).

Polarisation Data for Experiment 18B

Data for Cell Operation Using Scaled and Sanded Electrodes and Conducting Plates

EXPERIMENT NO. : CARBONATION

ANOLYTE : 20 L AT 75G/L NA2CO3
CATHOLYTE : 15 L AT 10% NAOH
ABSORBTION COL : 35 L SCOUR EFFLUENT INITIALLY, TOTAL = 67 L

SAMPLE	TIME (h-min)	CURRENT DENSITY (A/sq.m)	FARADAY PASSED (F)	VOLTAGE (V) OVERALL	CELL	MEMBRANE	C-M	A-M	TEMP. CELSIUS	VOLUME (l)	SAMPLE ANALYSIS pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	OH- (g/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	Na+ (g/l)	Ca++ (mg/l)	Mg++ (mg/l)	COD (g/l)	TS (g/l)
ANOLYTE	0,00	40	0,0	4,1		0,17			28	20,0	11,4	66		10,9		0,1	38,6	0,0	28,3	31,0				
CATHOLYTE		200		4,9		0,16				15,0		21				31,3	4,8		3,5	48,0				
ABS.COL.		500		5,8		0,16				35,0	12,7	23	1,8	0,1	1,7	1,0	2,4	0,0	1,3	3,8	15	2	3,0	8,3
		1000		7,1		0,16																		
		1500		8,5	3,9	0,16	1,9	1,9																
ANOLYTE	0,35	1500	1,5	8,4		0,21			35		10,2													
ANOLYTE	1,30	1500	4,0	8,2		8,10			44	19,4	9,7	56		11,9		0,0	19,7	21,7	30,1	23,8				
CATHOLYTE										15,9						38,3	7,0	0,0	5,1	58,0				
ABS.COL.										35,0	12,7	22	1,8	0,2	1,6	1,3	1,2	0,0	0,9					
ANOLYTE	2,40	1500	7,3	8,7		0,08				18,7	9,0													
										16,3														
		2000		10		0,05																		
ANOLYTE	3,15	2000	9,4	11,2		0,08					8,5													
ABS.COL.		1500		9,6		0,14					12,4													
ANOLYTE	3,20	1500	9,6	9,7		0,15			50	18,2	8,2	37		3,5		0,0	0,0	36,4	26,3	14,1				
CATHOLYTE										16,8		27				41,9	7,7	0,0	5,6	65,9				
ABS.COL.										35,0	10,1	10	1,4	0,6	0,8	0,0	2,9	1,1	2,9					
ANOLYTE	3,40	1500	10,6	9,6							10,1													
ANOLYTE	3,50	1500	11,3	9,7							9,3													
ANOLYTE	4,05	1500	11,6	9,9							9													
ANOLYTE	4,25	1500	12,6	10,4		0,01			50	17,6	8,2	26		2,4		0,0	6,5	9,0	11,3	8,4				
CATHOLYTE										17,4						48,7	5	0	3,7	68				
ABS.COL.										35	8,7	10	1,8	1,2	0,6	0	0,6	5,7	4,6				4,4	
	TRANSFERRED 32 L FROM THE ABSORPTION COLUMN TO CROSS-FLOW MICROFILTRATION																							
	ADDED 32 L FRESH EFFLUENT OF THE FOLLOWING COMPOSITION:										10	11	2	0,9	1,1	0	3,1	1,8	3,6	2,9			4,0	
ABS.COL.	4,55	1500	14,1	11,7						32+35	10,5	7												
ABS.COL.	5,10	1500	14,8	13,3		0,6				32+35	9,8													
		1200		11,5																				
ABS.COL.	5,30	1200	15,6	14,7					52		8,9													
ANOLYTE		1200	15,7	15,5	6,23	0,61	0,76	4,8		16,5	7,6	8		0,8		0	0	5,6	4	2				
CATHOLYTE		500		9,1						17,4		29				49,9	8,9	0	6,5	74				
ABS.COL.		200		6,3						32+35	8,7	11	2,3	1,2	1,5	0	0,6	6,5	5,1	3,2			5,8	
		60		5																				

COMMENTS : DURING THIS EXPERIMENT THE CATHOLYTE TURNED SLIGHTLY BROWN.

AS TABLE 2

EXPERIMENT 1: MICROFILTRATION

FEED: 35L EFFLUENT FROM EXP 1 CARBONATION, TOTAL = 67L

TIME (h-min)	SAMPLE	VOL (l)	PERM. RECOVERY (%)	FLUX (l/m2/h)	SAMPLE ANALYSIS pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	COO (g/l)	Na (g/l)	Ca (mg/l)	Mg (mg/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	TS (g/l)	POINT REJECTION (%) COND	TC	IC	OC	COD	Na	Ca	Mg	TOT. CO2	TS
0.0	FEED	35.0			7.9	10.0	2.0	0.9	1.1	1.6	2.7	17.5	1.0	0.0	6.8	4.9	8.8										
.	PERM	0.0	0.0	13.9 @ 350KP	8.3	9.0	1.3	0.9	0.4	1.0	2.6	14.0	1.0	0.2	6.2	4.6	7.7	2.0	35.0	0.0	63.6	37.5	3.7	20.0	0.0	6.1	12.5
ADDED FURTHER 32L CARBONATED EFFLUENT FROM EXPERIMENT 1 CARBONATION																											
	FEED	10.0			7.9	11.0	5.9	0.7	5.2	11.4	3.2	45.0	1.0	0.0	7.8	5.6	20.5										
	PERM	55.0	82.0		8.9	11.0	1.8	0.8	1.0	7.7	3.1	12.0	1.0	0.6	5.9	4.7	8.9	5.0	70.0	0.0	80.7	32.4	3.1	73.3	0.0	16.1	56.6

COMMENTS: NOTE: EVAPORATIVE LOST ABOUT 2L. COMPANY:

AS TABLE 3

EXPERIMENT 1: NANOFILTRATION

FEED: SSL FROM EXP 1 CROSS-FLOW MICROFILTRATION

TIME (h-min)	SAMPLE	VOL (l)	PERM. RECOVERY (%)	FLUX (l/m2/h)	SAMPLE ANALYSIS pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	COD (g/l)	Na (g/l)	Ca (mg/l)	Mg (mg/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	TS (g/l)
0	FEED	55			8.2	10	1.5	0.6	0.9	2.0	2.6	10	1	0.7	5.1	4.2	7.7
	PERM	0	0	32.1 @ 1,6MP 14 C	8.3	2	0.5	0.3	0.2	0.1	0.5	0.5	0	0	1.1	0.8	1.4
0.4	PERM	10	18	35.7 @ 1,4MP 19 C													
1.1	PERM	20	36	37.7 @ 1,4MP 23 C													
1.4	PERM	30	55	33.7 @ 1,6MP 28 C													
2.2	PERM	40	73	35.7 @ 1,4MP													
	FEED	5			9	37	13.1	2.6	10.5	38.7	14.6	136	36	3.9	24.6	20.6	54.6
	PERM	50	91		8.7	28	3.1	2.4	0.7	1.2	9.5	17	3	3	16	13.7	24.2

TIME (h-min)	SAMPLE	POINT REJECTION (%) COND	TC	IC	OC	COD	Na	Ca	Mg	TOT. CO2	TS
0	FEED										
	PERM	76	67	50	77.7	95	80.8	100	100	80.9	81.8
0.4	PERM										
1.1	PERM										
1.4	PERM										
2.2	PERM										
	FEED										
	PERM	24	76	7.7	93.3	96.9	34.9	87.5	91.7	33.5	55.7

COMMENTS:

COMPANY:

AS TABLE 4

EXPERIMENT NO:1 ELECTROLYSIS OF EFFLUENT SAMPLE A

ANOLYTE : 25 L PERM FROM EXP 1 NF
CATHOLYTE : 16 L NAOH
ABSORBTION COL : 25 L SCOUR EFFLUENT

SAMPLE	TIME (h-min)	CURRENT DENSITY (A/sq.m)	FARADAY PASSED (F)	VOLTAGE (V)					TEMP. CELSIUS	VOLUME (l)	SAMPLE ANALYSIS													
				OVERALL	CELL	MEMBRANE	C-M	A-M			pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	OH- (g/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	Na+ (g/l)	Ca++ (mg/l)	Mg++ (mg/l)	COD (g/l)	TS (g/l)
ANOLYTE	0,00	80	0,0	5,9					21	25,0	7,8	7	0,4	0,4	0,0	0,0	0,2	3,9	3,0	1,8	2	0		
CATHOLYTE		200		7,4						16,0		28				64,7	5,8	0,0	4,3	67,8				
ABS.COL.		500		12,2						25,0	12,7	20	1,6	0,2	1,4	1,4	1,6	0,0	1,2	3,9				
		700		16,3	7,2	0,76	0,8	5,7																
	0,15	700	0,3	17,5																				
	0,25	700	0,5	19,3																				
		500		15																				
ANOLYTE	0,30	500	0,6	16,9	7,7	0,91	0,7	6,1	29	24,7	7,1	4	0,4	0,2	0,2	0,0	0,0	2,7	1,9	1,0				
CATHOLYTE										16,1						63,9	5,5	0,0	4,0	64,1				
ABS.COL										25,0	12,6	18	1,3	0,2	1,6	1,1	2,3	0,0	1,7					
	0,43	500	0,7	18,8																				
		400		16																				
	0,52	400	0,9	18,3																				
	0,55	400	0,9	19,2																				
		300	0,9	16																				
ANOLYTE	1,10	300	1,0	21					37	24,6	6,5	1,8	0,2	0,1	0,1	0,0	0,0	0,5	0,4	0,3	1	0		
CATHOLYTE		100		8,2						16,3		27,8				52,6	5,3	0,0	3,9	65,0				
ABS.COL.										25,0	12,1	13,4	1,6	0,3	1,4	0,7	3,1	0,0	2,3					

AS TABLE 5

EXPERIMENT NO 1 : ELECTROLYSIS OF EFFLUENT SAMPLE B

ANOLYTE : 32 L OF EXP 1 NF PERM
CATHOLYTE 16 L OF NAOH FROM EXP 1 CELL A
ABSORBTION COL : 25 L FROM EXP 1 CELL A = 5 L SCOUR EFFLUENT

SAMPLE	TIME	CURRENT DENSITY	FARADAY PASSED	VOLTAGE (V)					TEMP. CELSIUS	VOLUME	SAMPLE ANALYSIS													
	(h-min)	(A/sq.m)	(F)	OVERALL	CELL	MEMBRANE	C-M	A-M		(l)	pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	OH- (g/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	Na+ (g/l)	Ca++ (mg/l)	Mg++ (mg/l)	COD (g/l)	TS (g/l)
ANOLYTE	0,00	60	0,0	5,5					26	32,0	8,5	7	0,5	0,4	0,0	0,0	0,4	4,0	3,2	1,8	2	0,5		
CATHOLYTE		300		9,1						16,0		27				50,9	7,2	0,0	5,3	70,0				
ABS.COL.		500		12,1						25,0	12,3	15	1,8	0,3	1,5	0,7	2,9	0,0	2,1	3,8				
		700		15,2	6,5	0,97	0,6	4,9																
	0,18	700	0,3	16,2																				
	0,33	700		17,5																				
		500	0,5	13,8																				
ANOLYTE	1,13	500	0,9	17					39	31,9	7,0	4	0,5	0,3	0,2	0,0	0,0	2,7	2,0	1,1				
CATHOLYTE										16,3						53,2	3,8	0,0	2,7	69,8				
ABS.COL.										25,0	11,4	12	1,5	0,0	1,5	0,5	3,2	0,0	2,3					
	1,13	500	1,1	21																				
		300		13,5																				
ANOLYTE	1,28	300	1,3	17,2		0,81				31,9	6,3	2	0,2			0,0	0,0	0,7	0,5	0,4	0,5	0		
CATHOLYTE										16,3		26				56,3	4,8	0,0	3,5	67,0				
ABS.COL.										25,0	10,3	12	2,0	0,9	1,1	0,0	3,5	1,5	3,6					

[illegible] : 15% NAOH
ABSORBTION COL : 40 L SCOUR EFFLUENT INITIALLY, TOTAL = 75 l

SAMPLE	TIME	CURRENT DENSITY	FARADAY PASSED	VOLTAGE (V)					TEMP. CELSIUS	VOLUME	SAMPLE ANALYSIS													
	(h-min)	(A/sq.m)	(F)	OVERALL	CELL	MEMBRANE	C-M	A-M		(l)	pH	COND (mS/cm)	TC (g/l)	TC (g/l)	IC (g/l)	OH- (g/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	Na+ (g/l)	Ca++ (mg/l)	Hg++ (mg/l)	COD (g/l)	TS (g/l)
ANOLYTE	0,00	60,0	0,0	3,8					18,0	50,0	11,5	67,0		7,5		0,0	52,9	1,1	39,6	45,0	6,0	2,0		
CATHOLYTE		500,0		5,9						15,0		11,0				21,9	7,7	0,0	5,5	30,9				
ABS.COL.		1000,0		7,7						40,0	13,7	86,0	4,0	0,4	3,6	7,7	3,2	0,0	2,3	11,9	45,0	0,0	13,7	
		1500,0		9,4	4,2	0,94	1,7	3,4																
	1,00	2500,0	1,2	10,3	4,5	0,91	1,7	3,8	26,0															
ANOLYTE	2,00	2000,0	2,8	9,8					29,0	49,4	10,8	67,0		5,2		0,4	61,1	0,0	44,0	29,4				
CATHOLYTE										15,4						22,8	1,9	0,0	1,4	32,8				
ABS.COL.										40,0	13,7	78,0	3,4	0,2	3,2									
	2,30	2000,0	5,2	9,2																				
ANOLYTE	3,00	2000,0	6,8	9,0	3,9	0,76	1,7	3,2	39,0	49,0	10,5													
CATHOLYTE										16,0														
ABS.COL.											12,4													
ANOLYTE	4,00	2000,0	10,1	8,9		0,70			43,0	48,1	9,6	61,0		6,2		0,0	35,2	18,7	39,3	33,0				
CATHOLYTE										16,5						31,2	2,4	0,0	1,7	40,8				
ABS.COL.										40,0	13,7	86,0	3,3	0,2	3,2									
ANOLYTE	4,30	2400,0	12,6	9,5	4,0	0,70			47,0	47,7	9,5													
ANOLYTE										17,0														
CATHOLYTE										40,0														
ABS.COL.																								
ANOLYTE	5,30	2400,0	18,0						53,0	47,2	9,3	55,0		7,6		0,0	21,2	33,6	39,8	29,0				
CATHOLYTE										17,7		18,0				35,5	1,2	0,0	0,9	52,2				
ABS.COL.										40,0	13,6	84,0	6,0	0,2	5,8									
		2000,0	18,1	8,6		0,40																		
ANOLYTE	8,50	2000,0	29,1	9,4	4,0	0,20	1,4	2,9	53,0	44,9	8,3	43,0		7,1		0,0	3,2	47,0	36,1	19,1				
CATHOLYTE										19,7						41,3	4,1	0,0	3,0	62,0				
ABS.COL.										40,0	13,4	50,0	6,6	1,2	5,4	2,9	9,8	0,0	7,1					
ANOLYTE	9,30	2000,0	31,9	9,7		0,20				44,6	12,1													
CATHOLYTE										20,1														
ABS.COL.										40,0	10,7													
		1500,0		8,4																				
ANOLYTE	10,5	1500,0	35,4	8,8		0,2			50,0	43,3	7,9	[illegible]		3,7		0,0	8,8	23,9	23,5	17,0				
CATHOLYTE										20,5						44,1	2,9	0,0	2,1	64,8				
ABS.COL.										40,0	9,9	30,0	8,1	2,5	5,6	0,0	9,8	5,4	11,0					
ANOLYTE	11,3	1500,0	37,4	9,0		0,2			48,0	42,7	7,7													
CATHOLYTE										20,7														
ABS.COL.										40,0	8,9													
ANOLYTE	12,1	1500,0	39,4	9,2		0,2			48,0	42,8	8,5	34,0		3,4		0,0	9,5	13,7	16,8	13,0				
CATHOLYTE										21,0		26,0				49,8	2,6	0,0	1,9	75,5				
ABS.COL.										40,0	9,1	30,0	10,6	3,2	7,4	0,0	4,6	21,7	19,0		42,0	7,0	5,7	
AT THIS STAGE THE EFFLUENT IN THE ABSORPTION COLUMN WAS TRANSFERRED TO CROSS-FLOW MICROFILTRATION AND 35 L OF SCOUR EFFLUENT WAS ADDED TO THE COLUMN																								
ANOLYTE	12,3	1500,0	40,7	9,4					49,0	42,6	8,0	30,0		3,0		0,0	4,1	19,5	17,1	13,4				
CATHOLYTE										21,4										68,5				
ABS.COL.										40 + 35	13,7	73,0	6,5	1,0	5,5	5,5	6,5	0,0	4,7	12,6	35,0	6,0	7,8	
ANOLYTE	13,4	1500,0	43,5	10,0					49,0	41,5	8,4	24,0		2,6		0,0	2,8	17,9	15,0	10,0				
CATHOLYTE										21,7						48,3	1,9	0,0	1,4	66,6				
ABS.COL.											13,4	48,0	8,3	1,3	7,0	2,0	12,2	0,0	8,8					
	16,2	1400,0	50,5	15,6																				
ANOLYTE	16,3	1400,0		16,8		0,2			50,0	39,9	7,2	8,7		1,1		0,0	0,8	5,5	4,6	2,6	1,0	1,0		
CATHOLYTE		1400,0	51,4							22,7		25,5				50,2	3,1	0,0	2,2	67,2				
ABS.COL.										40 + 35	9,3	32,0	7,1	3,8	3,3	0,0	6,5	18,5	18,1		36,0	6,0	[illegible]	

AS TABLE 7

EXPERIMENT 2: MICROFILTRATION

FEED: 75L EFFLUENT FROM EXP 2 CARBONATION

TIME (h-min)	SAMPLE	VOL (l)	PERM. RECOVERY (%)	FLUX (l/m2/h)	SAMPLE ANALYSIS													POINT REJECTION (%)									
					pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	COD (g/l)	Na (g/l)	Ca (mg/l)	Mg (mg/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	TS (g/l)	COND	TC	IC	OC	COD	Na	Ca	Mg	TOT. CO2	TS
0.00	FEED	75			9.3	32	8.3	2.8	5.5	5.0	14.8	29	7	1.1	28.8	21.6	33.2										
2.30	PERM	0	0	30 @ 200KP 24C																							
3.30	PERM			4.9 @ 200KP 25C	9.3	32	7	2.8	4.3	4.6	14.7	22	9	1.1	28.2	21.1	32.6	0	16	0	22	8	0	24	0	2	2
	FEED	10			9.4	32	11.3	4.3	7	16.7	13.5	35	9	4.2	23.9	20.3	43.1										
	PERM	50	67		9.4	32	7	3.1	3.9	5.2	15.1	39	9	3.6	23.8	19.8	34.2	0	38	28	44	69	0	0	0	2	21

COMMENTS: EVAPORATIVE LOSS 15L

AS TABLE 8

EXPERIMENT 2 : NANOFILTRATION

FEED: SOL FROM EXPERIMENT 2 CROSS-FLOW MICROFILTRATION

TIME (h-min)	SAMPLE	VOL (l)	PERM. RECOVERY (%)	FLUX (l/m2/h)	SAMPLE ANALYSIS														POTNT REJECTION (%)									
					pH	COND (mS/cm)	TC (g/l)	TC (g/l)	OC (g/l)	COD (g/l)	Na (g/l)	Ca (mg/l)	Mg (mg/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	TS (g/l)	COND	TC	IC	OC	COD	Na	Ca	Mg	TOT. CO2	TS
0.00	FEED	50		all @ 1,6MPa	9.4	32	8.3	3.7	4.4	7.5	14.4	40	8	3.2	25.5	20.7	33.6										
1.30	PERM	10	20	33.3	9.3	29	7.9	1	6.1	1.0	12	19	8	4.7	22.4	19.6	31.3	9	5	73	0	87	17	52	0	5	7
3.00		20	40	15.3 @ 36C																							
5.00		30	60	14.6 @38C																							
6.20		40	80	10.5 @ 40C																							
7.30	FEED	5			10.1	39	25	6	19.1	52.5	20	329	43	16.1	13.9	21.8	86.4										
	PERM	43	86		9.8	28	5	2.5	25.4	2.5	10.4	13	5	6.5	13.1	14.2	24.9	28	80	58	0	95	48	96	88	35	71

COMMENTS: NOTE: EVAPORATIVE LOSS ABOUT 2L.

AS TABLE 9

EXPERIMENT NO 2: ELECTROLYSIS OF EFFLUENT SAMPLE

ANOLYTE : 20 L FROM EXP. 2 NF
CATHOLYTE 15 L FROM EXP. 2 CARBONATION
ABSORBTION COL : 25 L SCOUR EFFLUENT

SAMPLE	TIME (h-min)	CURRENT DENSITY (A/sq.m)	FARADAY PASSED (F)	VOLTAGE (V) OVERALL	CELL	MEMBRANE	C-M	A-M	TEMP. CELSIUS	VOLUME (l)
ANOLYTE	0,00	60	0,0	4,8	2,5	0,17	1,3	1,4	24	20,0
CATHOLYTE										15,0
ABS.COL.										25,0
	0,10	600	0,0	8,3						
	0,25	1200	0,3	11,9		0,50				
ANOLYTE	1,00	1200	1,7	13,3					38	17,2
CATHOLYTE										15,6
ABS.COL.										25,0
	1,25	1000	2,5	13,4						
	1,40	800	3,1	14,8						
	1,55	600	3,4	13,8						
ANOLYTE	2,03	600	3,5	15		0,30			46	16,5
CATHOLYTE										15,9
ABS.COL.										25,0
		400	3,6	11,8						
ANOLYTE	2,35	400	3,8	15		0,50			53	16,3
CATHOLYTE										16,1
ABS.COL.										25,0

SAMPLE	TIME (h-min)	SAMPLE ANALYSIS pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	OH- (g/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	Na+ (g/l)	Ca++ (mg/l)	Mg++ (mg/l)	COD (g/l)	TS (g/l)
ANOLYTE	0,00	8,8	19	3,5	1,2	2,3	0,0	3,8	8,3	8,8	6,0	5,1	1,5	0,4	
CATHOLYTE			18				33,2	3,6	0,0	2,6	49,3				
ABS.COL.		13,7	97	3,9	0,2	3,7	8,0	2,5	0,0	1,8	13,3				
	0,10														
	0,25														
ANOLYTE	1,00	8,1	15,3	3,0	1,2	1,8	0,0	2,9	7,1	7,2	4,6				
CATHOLYTE							34,0	2,9	0,0	2,1	53,5				
ABS.COL.		13,6	86,9	4,0	0,8	3,5	6,7	5,0	0,0	3,7					
	1,25														
	1,40														
	1,55														
ANOLYTE	2,03	8,4	3,9	0,9	0,2	0,7	0,0	0,2	1,3	1,1	1,0				
CATHOLYTE							37,9	4,1	0,0	3,0	55,5				
ABS.COL.		13,4	58,7	5,5	1,0	4,5	3,3	10,7	0,0	7,8					
ANOLYTE	2,35	8,9	2	0,8	0,6	0,2	0,0	0,0	0,9	0,7	0,5	0	1	0,2	1,9
CATHOLYTE			27					2,6	0,0	1,9	58,5				
ABS.COL.		13,3	55	6,3	2,5	3,8	2,8	12,1	0,0	8,7					

DURING THIS EXPERIMENT A TWISTED GAS LINE MAY HAVE INHIBITED CO2 PASSAGE FROM THE ANOLYTE TANK TO THE ABSORPTION COLUMN.

A7 TABLE 10

EXPERIMENT NO 2 : ELECTROLYSIS OF EFFLUENT SAMPLE B

ANOLYTE : 20 L FROM EXP. 2 NF
CATHOLYTE : 16 L AT 100G/L NaOH
ABSORBTION COL : 25 L FROM EXP. 2 CELL A + 5 L SCOUR EFFLUENT

SAMPLE	TIME (h-min)	CURRENT DENSITY (A/sq.m)	FARADAY PASSED (F)	VOLTAGE (V) OVERALL	CELL	MEMBRANE	C-M	A-M	TEMP. CELSIUS	VOLUME (l)	SAMPLE ANALYSIS pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	OH- (g/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	Na+ (g/l)	Ca++ (mg/l)	Mg++ (mg/l)	COD (g/l)	TS (g/l)
ANOLYTE	0,00	1200	0,0	11,2	5,8	0,14	0,9	4,0	25	20,0	8,4	15	3,2	2,3	0,9	0,0	2,0	9,3	8,3	5,7				
CATHOLYTE										16,0						32,3	2,4	0,0	1,8	53,1				
ABS.COL.										30,0	13,5	63	5,3	1,8	3,5	3,6	10,0	0,0	7,3	12,4	4	4	7,7	
ANOLYTE	1,00	1200	1,4	14,3					36	18,5	8,1	15	2,9	1,0	1,9	0,0	1,3	9,3	7,8	4,9				
CATHOLYTE		1000		13,1						16,5						34,7	1,9	0,0	1,4	56,1				
ABS.COL.										30,0	13,0	62	5,8	2,6	3,1	3,5	10,4	0,0	7,6	15,1				
	1,22	1000	2,1	15																				
		800		12,9																				
	1,35	800	2,4	15																				
		600	2,4	12,2																				
	1,46	600	2,6	15																				
		400		11,5																				
	2,00	400	2,7	14,2					45															
ANOLYTE	2,08	400	3,0	15		0,19			48	18,5	6,8	2,8	0,8	0,5	0,3	0,0	0,0	1,7	1,2	0,7	4	1	0,5	
CATHOLYTE										16,9		28				37,5	0,7	0,0	0,2	58,3				
ABS.COL.										30,0	13,4	63	5,3	2,0	3,3	3,7	10,3	0,0	7,7	15,0				

DATE:

SAMPLE	TIME	CURRENT DENSITY	FARADAY PASSED	VOLTAGE (V)					TEMP. CELSIUS	VOLUME	SAMPLE ANALYSIS													
	(h-min)	(A/sq.m)	(F)	OVERALL	CELL	MEMBRANE	C-M	A-M		(l)	pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	OH- (g/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	Na+ (g/l)	Ca++ (mg/l)	Mg++ (mg/l)	COD (g/l)	TS (g/l)
ANOLYTE	0,00	2000,0	0,0	9,8	4,2	0,15	1,5	2,7	22,0	50,0	11,4	63,5	10,1	4,6	5,5	0,0	47,0	0,0	34,5	45,0				
CATHOLYTE										15,0		18,0				31,4	1,2	0,0	0,9	48,9				
ABS. COL.										40,0	13,5	71,5	4,8	1,6	3,2	4,8	7,9	0,0	5,7	13,8	32,0	3,0	8,9	
	1,05	2000,0	3,2	9,0					36,0															
		2400,0		10,0																				
ANOLYTE	1,40								40,0		10,5													
	2,10	2400,0	8,1	9,2																				
ANOLYTE		2600,0		9,6					47,0		9,8													
ANOLYTE	2,25	2600,0	9,9	9,5					49,0		9,7													
ANOLYTE	2,40	2600,0	11,2	9,4					51,0	48,3	9,5	67,6	12,3	7,1	5,2	0,0	35,5	23,2	42,6	33,0				
CATHOLYTE										16,3						50,0	1,7	0,0	1,2	62,0				
ABS. COL.										40,0	13,6	71,7	4,1	1,3	2,2									
ANOLYTE	3,35	2600,0	15,0	9,4					54,0	47,5														
CATHOLYTE										16,7														
	3,45	2400,0	15,8	9,0																				
	4,30	2420,0	19,1	9,2																				
	4,55	2420,0	21,2	9,6																				
ANOLYTE	5,50	2420,0	25,2						56,0	48,2	8,5													
CATHOLYTE										18,2														
ABS. COL.											12,5													
		2000,0		9,3																				
	6,45	2000,0	28,6	10,4																				
		2200,0		11,2																				
ABS. COL.	7,20	2200,0	30,9	10,7					56,0		11,2													
		2000,0		9,7																				
ABS. COL.	7,40	2000,0		9,7							10,1													
ABS. COL.	8,15	2000,0	34,3	9,9		0,22			55,0		9,7													
ANOLYTE	9,20	2000,0	36,5	10,2		0,21			56,0	42,9	8,3	38,6	8,1	5,7	2,4	0,0	1,3	40,0	29,3	16,0				
CATHOLYTE										20,1						94,2	3,6	0,0	2,6	110,8				
ABS. COL.										40,0	9,1	33,7	9,4	2,9	6,5	0,0	2,8	27,8	22,0	14,6				
AT THIS STAGE 10 L HAS TRANSFERRED FROM ABS. COL. TO CMF. ADDED 35 L SCOUR EFFLUENT TO ABS COL.																								
	10,3	2000,0	42,8	10,8					54,0	40 + 35														
ABS. COL.	11,4	2000,0	47,1	12,0					56,0		9,9													
		1800,0		11,2																				
ANOLYTE	12,1	1800,0	49,0	12,0					56,0	40,8														
CATHOLYTE										21,7														
ABS. COL.										40 + 35	9,5													
		1600,0		11,2																				
ANOLYTE	12,4	1600,0	50,1	11,8		0,2			55,0	40,5	8,2	16,0	2,9	0,8	2,1	0,0	0,0	13,5	9,7	5,9				
CATHOLYTE										21,7		40,0				80,7	6,0	0,0	4,4	138,0				
ABS. COL.										40 + 35	9,2	32,0	9,9	2,1	7,8	0,0	10,9	10,6	15,5	12,6			8,8	
AT THIS STAGE 35 L HAS TRANSFERRED TO EXPERIMENT 3 CROSS-FLOW MF. ADDED 60 L SCOUR EFFLUENT TO ABS.COL. [illegible] OF NAHCO3 TO THE ANOLYTE (32 L) [illegible] H2O TO CATHOLYTE																								
	3,0	1500,0		9,2																				
	2	1500,0	67,5	9,3					,0	75 + 60	9,5													
		1800,0		10,3																				
	[illegible]	2000,0		11,0																				
AF[illegible]	[illegible]	2000,0	69,4	11,0						75 + 60	8,8													
A[illegible] [illegible] EFFLUENT IN THE ABSORPTION COLUMN HAS TRANSFERRED TO THE CROSS-FLOW MICROFILTER. 3KG [illegible] ADDED TO THE ANOLYTE AND 65L OF SCOUR EFFLUENT HAS CARBONATED IN THE ABSORPTION COLUMN																								
ANOLYTE	28,2	1900,0	99,4	11,2						25,0														
CATHOLYTE										29,0											123,0			

AS TABLE 12

EXPERIMENT 3 : MICROFILTRATION

FEED: 75L CARBONATED EFFLUENT FROM EXPERIMENT 3 CARBONATION

			SAMPLE ANALYSIS													POINT REJECTION (%)									
TIME (h-min)	SAMPLE		COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	COD	Na (g/l)	Ca (mg/l)	Mg (mg/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	TS (g/l)	COND	TC	IC	OC	COD	Na	Ca	Mg	TOT. CO2	
0.00	FEED		34	9.4	2.9	6.5	7.2	14.6	32	3	2.8	27.8	22.1	36.3										
	PERM		33	7	3.9	3.1		14.1	26	3	11.3	10.9	16.2	36.3	1	26	0	52		3	19	0	27	
9.30	PERM	53																						
10.30	FEED	10		8.3	1.8	6.5	17.0	14.5	72	7	10.7	12.6	16.9	44.2										
	PERM	55		7.4	0.9	6.5	11.0	14.1	46	7	16.4	1.1	12.8	38.04	0	11	50	0	36	2	35	0	25	14
11.00	ADDED 65L CARBONATED EFF																							
15.00	ADDED FURTHER 65L CARBONATED E																							

COMMENTS: NOTE: EVAPORATIVE LOSS ABOUT 10%.

AS TABLE 13

EXPERIMENT 3: NANOFILTRATION

FEED: SSL FROM EXPERIMENT 3 CROSS-FLOW MICROFILTRATION

TIME	SAMPLE	VOL	PERM. RECOVERY	FLUX	SAMPLE ANALYSIS													POINT REJECTION (%)									
					pH	COND	TC	IC	OC	COD	Na	Ca	Mg	CO3=	HCO3-	TOT. CO2	TS	COND	TC	IC	OC	COD	Na	Ca	Mg	TOT. CO2	TS
(h-min)		(l)	(%)	(l/m2/h)		(mS/cm)	(g/l)	(g/l)	(g/l)	(g/l)	(g/l)	(mg/l)	(mg/l)	(g/l)	(g/l)	(g/l)	(g/l)										
0.00	FEED	55			9.2	33	9.6	4.1	5.5	5.6	13.6	26	5	15.5	1.7	12.6	36.1										
	PERM	0	0	14.3	9.1	20	3.3	1	2.3	0.2	6.8	3	2	5.8	5.4	8.1	16.7	39	66	76	58	96	50	89	60	36	54
				@ 16C																							
1.05	PERM	10	18	13.4																							
				@ 23C																							
2.20	PERM	20	36	12.8																							
				@ 30C																							
3.55	PERM	30	55	12.3																							
				@ 34C																							
4.55	PERM	40	73	12.1																							
				@ 38C																							
7.05	FEED	5			9.9	56	24.6	6.3	18.3	49.7	34.3	243	41	21	25.6	33.9	107.9										
	PERM	50	91	4.3	9.5	47	4.9	1.8	3.1	7.2	21.9	14	6	12.1	28.4	29.4	51.8	16	80	71	83	86	36	94	85	13	52
				@ 42C																							

COMMENTS:

COMPANY:

A5 TABLE 14

EXPERIMENT NO 14 : ELECTROLYSIS OF EFFLUENT SAMPLE A

ANOLYTE : 25 L NF PERM FROM EXP. 3 NF
CATHOLYTE : 15L NAOH
ABSORBTION COL : 25 L SCOUR EFFLUENT

SAMPLE	TIME (h-min)	CURRENT DENSITY (A/sq.m)	FARADAY PASSED (F)	VOLTAGE (V) OVERALL	CELL	MEMBRANE	C-M	A-M	TEMP. CELSIUS	VOLUME (l)	SAMPLE ANALYSIS pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	OH- (g/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	Na+ (g/l)	Ca++ (mg/l)	Mg++ (mg/l)	COD (g/l)	TS (g/l)
ANOLYTE	0,00	100	0,0	5,1					15	25,0	9,3	29,4	4,3	2,9	1,4	0,0	7,8	14,3	16,0	12,4	8	2		
CATHOLYTE		300		6,9						15,0						52,6	2,2	0,0	1,6	69,7				
ABS.COL.		600		8,5						25,0	13,2	28,7	6,5	0,9	5,6	3,7	2,6	0,0	1,9	7,5				
		900		10,3																				
		1200		12,1	6,4	0,19	1,3	4,7																
ANOLYTE	1,05	1200	2,3	11,9		0,19			35	24.7	9,2	21,6	3,2	2,0		0,0	4,4	9,5	10,1	7,7				
CATHOLYTE										15,1						44,4	2,9	0,0	2,1	72,5				
ABS.COL.										25,0	13,6	42	7,6	2,1	5,5	2,6	4,1	0,0	3,0					
	2,15	1200	5,0	14,3		0,15																		
	2,35	1200	5,3	15,1		0,12																		
		1000		13,2																				
		800		12,7																				
	3,12	800	6,5	15,2		0,01																		
		600		12,2																				
ANOLYTE	3,25	600	6,8	14,5		0,01			46	23,6	7,1	9,6	1,5	1,2	0,3	0,0	0,5	5,4	4,3	2,0	2	1		
CATHOLYTE										15,4		29,4				62,2	3,1	0,0	2,2	77,7				
ABS.COL.										25,0	9,5	20,9	4,8	2,3	2,5	0,0	4,9	8,8	9,9					
	3,35	600	6,9	15		0,12																		
		400		12,2																				
	3,57	400	7,1	15,1		0,09																		
		300	7,2	13,3																				
ANOLYTE	4,07	300	7,2	15,1		0,10				23,6	6,1	2,4	0,7	0,4	0,4	0,0	0,0	0,6	0,4	0,6	1	0,4		
CATHOLYTE										17,5		30,2				52,9	3,8	0	2,7	77,9				
ABS.COL.										25	9	21,7	7	2,3	4,7	0	2,2	15,4	12,7	8,3	27	4		

AS TABLE 15

EXPERIMENT NO 15: ELECTROLYSIS OF EFFLUENT SAMPLE B

ANOLYTE : 25 L FROM EXP 3 NF
CATHOLYTE : 13 L FROM EXP 3 CELL A
ABSORBTION COL : 25 L FROM EXP CELL A + 25 L RAW SCOUR

SAMPLE	TIME	CURRENT DENSITY	FARADAY PASSED	VOLTAGE (V)					TEMP. CELSIUS	VOLUME	SAMPLE ANALYSIS													
	(h-min)	(A/sq.m)	(F)	OVERALL	CELL	MEMBRANE	C-M	A-M		(l)	pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	OH- (g/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	Na+ (g/l)	Ca++ (mg/l)	Mg++ (mg/l)	COD (g/l)	TS (g/l)
ANOLYTE	0,00	100	0,0	5,1					15	25,0	8,6	18,2	3,0	2,6	0,4	0,0	7,8	14,3	16,0	12,2	3,4	1		
CATHOLYTE		300		6,8						13,0		27,5				47,7	3,4	0,0	2,4	75,2				
ABS.COL.		600		8,7						50,0	12,9	33,4	6,3	2,4	3,9	0,9	9,7	0,0	7,0	9,4				
		900		10,7																				
		1200		13	7,3	0,07	1,6	5,5																
ANOLYTE	2,25	1200	4,1	15		0,06			39	24,4														
CATHOLYTE										13,7						53,4	3,8	0,0	2,7	75,3				
ABS.COL.										50,0	11,2	25,8	6,5	2,4	4,1	0,0	11,0	0,1	8,1					
		1000		13,4																				
	2,50	1000	5,0	15,1																				
		800		12,9																				
	3,15	800	5,6	15,1																				
		600		12,3																				
	3,50	600	6,2	15,2																				
		400		13,5		0,06																		
	4,10	400	6,5	15,1																				
		300		14,8																				
ANOLYTE	4,15	300	6,6	15,1		0,06			42	23,6	6,7	5,8	0,8	0,7	0,1	0,0	0,0	3,2	2,3	1,6	1	1		
CATHOLYTE										13,7		31,3				53,9	5,5	0,0	4,0	80,2				
ABS.COL.										50,0	9,5	25,1	4,3	2,7	1,6	0,0	5,6	12,1	12,8					

AS TABLE 16

EXPERIMENT NO 4 : CARBONATION

ANOLYTE : 50 L AT 40G/L NA2CO3 & 50G/L NAHCO3
CATHOLYTE : 12 L FROM EXP 3 CELL B
ABSORBTION COL : INITIALLY 50 L FROM EXP 3 CELL B + 10 L SCOUR, TOTAL = 160 L.

SAMPLE	TIME (h-min)	CURRENT DENSITY (A/sq.m)	FARADAY PASSED (F)	VOLTAGE (V) OVERALL	CELL	MEMBRANE	C-M	A-M	TEMP. CELSIUS	VOLUME (l)	SAMPLE ANALYSIS pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	OH- (g/l)	CO3- (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	Na+ (g/l)	Ca++ (mg/l)	Mg++ (mg/l)	COD (g/l)	TS (g/l)
ANOLYTE	0,00	60	0,0	3,3	5,7	0,06	1,6	3,8	18,00	50,0	9,6	157,90		10,0		0,0	24,6	21,4	33,5	30,0	3,50	1,50		
CATHOLYTE		300		5,5						12,0		27,70				46,7	5,0	0,0	3,6	70,3				
ABS.COL.		600		6,8						60,0	10,2	24,70	7,9	2,4	5,5	0,0	8,0	6,0	4,5	9,5	79,00	4,00	13,8	30,6
		1000		8,3																				
		1500		9,9																				
		2000		11,4																				
	1,00	2000	3,2	10,7		0,07																		
		2200		11,3																				
ANOLYTE	2,20	2200	8,5	10,6		0,04			46,00	49,4	8,7	51,20	9,1	8,6	0,5	0,0	9,1	43,3	37,7	25,0				
CATHOLYTE										13,2						56,6	3,8	0,0	2,7	80,0				
ABS.COL.										60,0	10,1	24,60	7,6	1,4	6,2	0,0	7,2	7,8	6,5					
ANOLYTE	4,05	2200	15,8	11,5		0,05					9,0													
CATHOLYTE		2000		10,9																				
ANOLYTE	4,30	2000	17,4	10,9		0,05				47,5	8,0	42,50	9,8	8,2	1,6	0,0	5,2	36,6	30,2	19,3				
CATHOLYTE										14,5						63,0	4,8	0,0	3,5	93,4				
ABS.COL.										60,0	9,1	25,00	5,5	2,3	2,7	0,0	4,0	15,0	13,7					
		1800		10,1																				
ADDED FURTHER 60 L FEED TO ABSORPTION COLUMN. TRANSFERRED INITIAL 60 L TO CROSS-FLOW MICRO-FILTRATION.																								
ABS.COL.	6,05	1900	22,9	10,8					63,00	60 + 60	11,7													
		1500		9,7																				
ABS.COL.		1500	24,6	10,0							9,6													
ANOLYTE	7,50	1500	27,9	10,6		0,21			65,00	45,0	7,9	29,00	8,0	3,7	4,3	0,0	4,7	19,3	17,4	11,3				
CATHOLYTE										15,6						72,1	5,3	0,0	3,8	104,8				
ABS.COL.										60 + 60	9,0	22,40	7,5	2,8	4,7	0,0	3,0	14,0	12,3				15,4	
ADDED 40 L FEED TO ABS. TANK.																								
	8,10	1300	28,5	9,7																				
ABS.COL.	9,05	1300	30,80	10,3					57,00	120 + 40	12,00													
		1500		11,5																				
ABS.COL.	9,50	1500	33,00	12,4					59,00	120 + 40	9,60													
ANOLYTE	10,50	1500	35,70	14,0		0,22			61,00	43,20	7,50	15,60	2,95	1,95	1,00	0,00	1,80	9,00	7,80	5,20	1,00	1,00		
CATHOLYTE		1000		10,0						16,80		42,00				78,90	5,50	0,00	4,00	108,00				
ABS.COL.		600		8,6						120 + 40	9,00	22,00	5,30	3,00	2,30	0,00	3,80	12,60	11,90		22,00	4,00	14,10	
		500		7,0																				
		200		5,5																				
		80		4,8																				
TRANSFERRED REMAINING 40 L TO CMF.																								

AS TABLE 17

EXPERIMENT 4: MICROFILTRATION

FEED: 60L FROM EXPERIMENT 4 CARBONATION, TOTAL FEED VOLUME = 160L.

TIME (h-min)	SAMPLE	VOL (l)	PERM. RECOVERY (%)	FLUX (l/m2/h)	SAMPLE ANALYSIS pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	COD (g/l)	Na (g/l)	Ca (mg/l)	Mg (mg/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	TS (g/l)	POINT REJECTION (%) COND	TC	TC	OC	COD	Na	Ca	Mg	TOT. CO2	TS
0.00	FEED	60			8.7	23	6.5	5.9	2.3		9.3	14.1	4.8	3.2	15.7	13.7	27.5										
	PERM	0	0	7 @ 200KP 7C																							
3.55	PERM	20	33.3																								
21.05	ADDED 100L FROM EXPERIMENT 4 CARBONATION AND RAN AT 200 KPa																										
64.00	PERM	40	27																								
72.35	PERM	65	43																								
75.55	FEED	10			9.3	23	26.3	1.8	24.6	70.2	7.7	3.2		3.7	15.9	14.2	59.4	SAMPLE VERY THICK, ANALYSIS DIFFICULT.									
	PERM	100	91		2.5	24	4.1	3.6	0.5	6.3	8	9	2.5	4.4	12.1	12	22.6	0	84	0	100	91	0		15.5	61.9	

COMMENTS: NOTE: EVAPORATIVE LOSS ABOUT 40L.

AS TABLE 18

EXPERIMENT 4: NANOFILTRATION

FEED: 60L FROM EXPERIMENT 4 CROSS-FLOW MICROOFILTRATION, TOTAL FEED VOLUME = 100L.

TIME (h-min)	SAMPLE	VOL (l)	PERM. RECOVERY (%)	FLUX (l/m2/h)	SAMPLE ANALYSIS pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	COD (g/l)	Na (g/l)	Ca (mg/l)	Mg (mg/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	TS (g/l)	POINT REJECTION (%) COND	TC	IC	OC	COD	Na	Ca	Mg	TOT. CO2	TS
0.00	FEED	60			9	24	3.6	3.6	0	5.1	8.3	9	7.1	4.6	10.9	11.2	22.1										
	PERM	0	0	10.2 @ 1,6MP 18C	9.1	20	2.2	2.4		1.2	6.3	3.2	4.1	3.4	1.3	9.2	15.3	17	39	33		77	24	64	42	18	31
AT THIS STAGE A LEAKAGE IN THE CARTRAGE FILTER WAS DISCOVERED. 60L OF FEED HAD BEEN LOST. RESTARTED THE EXPERIMENT WITH 60L CROSS-FLOW MICROFIL																											
13.50	PERM	0	0	6.1 @ 21C																							
16.20	PERM	10	17	7.7 @ 35C																							
18.00	PERM	20	33	8.8 @ 44C																							
20.30	PERM	30	50	8.1 @ 48C																							
22.10	PERM	33	55	7.9 @ 50C																							
ADDED 40L MICROFILTRATE TO THE TANK AND CONTINUED NANOFILTRATION.																											
22.10	PERM	43	43	7.7 @ 33C																							
24.25	PERM	53	53	6.7 @ 40C																							
27.25	PERM	63	63	5.4 @ 42C																							
29.55	PERM	73	73	4.3 @ 39C																							
31.55	PERM	83	83	4.2 @ 43C																							
33.55	FEED	5		9.4	SAMPLE TOO THICK FOR ANALYSIS.																						
	PERM	93	93		9.2	31	4.2	3.8	0.4	0.4	10.9	2	1	9.5	8.4	13	28										

COMMENTS: THE FINAL FEED WAS VERY THICK AND PROBABLY CAUSED PHYSICAL BLOCKAGE OF THE MEMBRANE PORES.

EVAPORATIVE LOSS ABOUT 4L.

AS TABLE 19

EXPERIMENT NO 4 : ELECTROLYSIS OF EFFLUENT SAMPLE A

ANOLYTE : 30 L FROM EXP 4 NF
CATHOLYTE : 15 L AT 100G/L NAOH
ABSORBTION COL : 30 L SCOUR EFFLUENT

SAMPLE	TIME (h-min)	CURRENT DENSITY (A/sq.m)	FARADAY PASSED (F)	VOLTAGE (V) OVERALL	CELL	MEMBRANE	C-M	A-M	TEMP. CELSIUS	VOLUME (l)	SAMPLE ANALYSIS pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	OH- (g/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	Na+ (g/l)	Ca++ (mg/l)	Mg++ (mg/l)	COD (g/l)	TS (g/l)
ANOLYTE	0,00	40	0,0	5					15	30,0	9,2	22,5	4,7	3,5	1,2	0,0	3,7	10,6	10,4	7,2	6	1,3	1,5	
CATHOLYTE		300		6,6						15,0		29,7		0,2		39,1	7,5	0,0	5,4	61,1				
ABS.COL.		600		8,5						30,0	13,4	51,6	5,5	0,2	5,3	2,9	3,5	0,0	2,5	7,2				
		1000		10,6	7,0	0,05	1,6	5,1																
	2,25	1000	4,0	15,1																				
		800		13,2																				
ANOLYTE	2,55	900	4,7	15,2						29,0														
CATHOLYTE										15,1														
ABS.COL.		600		12						30,0														
ANOLYTE	3,30	600	5,4	15					40	28,6	7,6	13,9	1,4	1,2	0,2	0,0	2,8	4,1	5,0	4,0				
CATHOLYTE										15,1						48,5	3,0	0,0	2,2	68,3				
ABS.COL.										30,0	9,2	21,9	6,9	2,5	4,4	0,0	2,5	14,5	12,3					
		400		11,3																				
	5,30	400	6,8	15																				
		300		11,9																				
ABS.COL.	6,20	300	7,2	15,1					42		8,6													
		200		12,4		0,04																		
ANOLYTE	6,55	200	7,4	14,3							4,9													
ABS.COL.											8,3													
	7	200	7,5	15,1																				
		60		7,7		0,01																		
		100	7,6	11,4		0,009																		
ANOLYTE	8,5	100	7,8	15		0,001			40	27,5	3,2	1,6	0,9	0,01	0,9	0	0	0,4	0,3	0,3	2,3	1	35,2	
CATHOLYTE										15,1		36,2				48,5	7,2	0	5,2	71,2				
ABS.COL.										30	8,9	22,3	7	3,8	3,2	0	3,2	11,8	10,9	7,3				

AS TABLE 20

EXPERIMENT NO 4 : ELECTROLYSIS OF EFFLUENT SAMPLE 8

ANOLYTE : 30 L FROM EXP 4 NF
CATHOLYTE : 12 L FROM EXP 4 CELL A
ABSORBTION COL : 30 L FROM EXP 4 CELL A + 30 L RAW SCOUR EFFLUENT

SAMPLE	TIME	CURRENT DENSITY	FARADAY PASSED	VOLTAGE (V)					TEMP. CELSIUS	VOLUME	SAMPLE ANALYSIS													
	(h-min)	(A/sq.m)	(F)	OVERALL	CELL	MEMBRANE	C-M	A-M		(l)	pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	OH- (g/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	Na+ (g/l)	Ca++ (mg/l)	Mg++ (mg/l)	COD (g/l)	TS (g/l)
ANOLYTE	0,00	100	0,0	5,5					20	30,0	9,3	22,5	4,7	3,5	1,2	0,0	3,7	10,6	10,4	7,2	6	1,3	1,5	
CATHOLYTE		300		8,1						12,0		25,1				44,3	7,2	0,0	5,2	61,8				
ABS.COL.		600		10,4						60,0	12,4	23,4	6,3	1,0	5,3	0,0	8,2	0,9	6,7	7,2				
		1000		12,9		0,16																		
	0,30	1000	0,4	15,1																				
		900		14,2																				
	1,00	900	1,5	15,1																				
		800		13,6																				
	1,15	800	1,9	15																				
		700		13,8		0,03			35															
ANOLYTE	3,45	700	5,1	15		0,06			44	28,6	7,2	11,8	2,2	1,2	1,0	0,0	1,8	4,1	4,3	3,5				
CATHOLYTE										12,7						46,9	6,5	0,0	4,7	70,6				
ABS.COL.										60,0	9,4	22	8,3	3,7	4,6	0,0	3,0	11,1	10,2	7,2				
		500		11,5																				
	5,40	500	6,9	15																				
		300		10,3		0,01																		
ANOLYTE	7,55	300	8,1	15,2					48	27,8	5,7	2,9	0,8	0,1	0,7	0,0	0,0	1,0	0,7	0,6				
CATHOLYTE										12,7						50,5	6,0	0,0	4,3	74,5				
ABS.COL.										60,0	9,0	22,1	8,4	3,2	5,2	0,0	1,4	14,6	11,6	7,1			14,8	
		100		8,4		0,02																		
	8,00	60		7,7																				
ANOLYTE	9,35	30	8,4	8		0,02			44	27,2	3,5	1,6		7,5		0,0	0,0	1,0	0,7	0,3	1	1	1,3	
CATHOLYTE										12,7		35,8				49,3	5,8	0,0	4,2	73,9				
ABS.COL.										60,0	8,6	22,2	7,0	4,0	3,0	0,0	2,2	13,5	11,4	8,4				24,2

AS TABLE 21

EXPERIMENT NO 21 : ELECTROLYSIS OF EFFLUENT SAMPLE C

ANOLYTE : 30 L FROM EXP 4 NF
CATHOLYTE : 12 L FROM EXP 4 CELLB
ABSORBTION COL : 30 L RAW SCOUR EFFLUENT

SAMPLE	TIME (h-min)	CURRENT DENSITY (A/sq.m)	FARADAY PASSED (F)	VOLTAGE (V) OVERALL	CELL	MEMBRANE	C-M	A-M	TEMP. CELSIUS	VOLUME (l)	SAMPLE ANALYSIS pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	OH- (g/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	Na+ (g/l)	Ca++ (mg/l)	Mg++ (mg/l)	COD (g/l)	TS (g/l)
ANOLYTE	0,00	60	0,0	5,4					22	30,0	9,1	22,5	4,7	3,5	1,2	0,0	3,7	10,6	10,4	7,2	6	1,3	1,5	
CATHOLYTE		300		7,7						12,0		28,7				45,8	5,5	0,0	4,0	61,7				
ABS.COL.		500		9,6						30,0	13,0	50,5	8,5	0,3	8,2	2,7	4,0	0,0	2,9	7,1				
		900		13,6																				
		1000		15,9		0,20																		
		900		14,7																				
	0,10	900		15,2																				
		600	0,2	14		0,20																		
ANOLYTE	1,25	600	1,5	10,5						29,8	7,8	17,5	6,5	2,1	4,4	0,0	3,0	0,0	2,2	5,4				
CATHOLYTE										12,0						47,1	6,2	0,0	4,5	62,7				
ABS.COL										30,0	13,1	36,4	10,3	0,5	9,8	1,5	5,8	0,0	4,2	7,1				
		800		12,3		0,20			40															
	2,27	800	2,7	12,7					45															
	3,20	800	4,1	15																				
		600		11,9		0,14																		
	4,34	600	5,6	15,1																				
ANOLYTE		400		11		0,10				29,3														
CATHOLYTE										12,2														
ABS.COL.										30,0	5,5													
ANOLYTE	5,45	400	6,5	14,8		0,01			45	27,9	8,4	2,2	1,0	0,1	0,9	0,0	0,0	0,4	0,3	0,5	1	0,4	1,7	
CATHOLYTE										12,2		32,2				47,9	7,0	0,0	5,0	69,2				
ABS.COL.										30,0	8,0	21,7		3,2		0,0	1,0	15,7	12,0	7,5				

AS TABLE 22

EXPERIMENT NO 5 : CARBONATION

ANOLYTE : 50 L AT 40G/L NA2CO3 AND 50G/L NAHCO3
CATHOLYTE : 15 L AT 100G/L NAOH
ABSORBTION COL : INITIALLY 60 L SCOUR EFFLUENT, TOTAL = 120 L.

SAMPLE	TIME (h-min)	CURRENT DENSITY (A/sq.m)	FARADAY PASSED (F)	VOLTAGE (V) OVERALL	CELL	MEMBRANE	C-M	A-M	TEMP. CELSIUS	VOLUME (l)	SAMPLE ANALYSIS pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	OH- (g/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	Na+ (g/l)	Ca++ (mg/l)	Mg++ (mg/l)	COD (g/l)	TS (g/l)
ANOLYTE	0,00	60	0,0	4,5					16	50,0	9,4	60,2		15,3		0,0	21,5	30,3	38,0	31,5				
CATHOLYTE		400		6,8						15,0		22,7				34,4	4,1	0,0	3,0	52,6				
ABS.COL.		800		8,6						60,0	13,1	48	5,1	0,2	4,9	2,3	3,2	0,0	2,3	6,7	48	6	10,9	
		1200		10,9																				
		2000		14,8		0,10																		
	0,15	2000	0,9	11,5																				
		2400		12,4																				
ANOLYTE	4,35	2400	20,5	12		0,02			54	47,2	8,6	50,3		9,0		0,0	8,5	36,2	32,3	21,2				
CATHOLYTE										18,2						46,3	6,5	0,0	4,7	74,9				
ABS.COL.										60,0	9,8	20	5,9	2,0	3,9	0,0	4,7	6,5	8,1	6,8				
		2300		11,2		0,00																		
ANOLYTE	6,00	2300	26,7	11,8		0,00			54	45,5	8,0	39,7		8,2		0,0	6,2	26,7	23,8	15,8				
CATHOLYTE										18,9						49,0	9,1	0,0	6,6	76,9			0,4	
ABS.COL.										60,0	8,6	19,3	9,1	2,5	6,6	1,9	13,8	0,0	10,1	6,5				
ADDED 60 L SCOUR EFFLUENT TO ABSORPTION COLUMN. ADDED A FURTHER 60 L OF EFFLUENT TO THE ABSORPTION COLUMN.																								
ABS.COL.	6,35	2300		12,2					54	60 + 60	12,7													
ABS.COL.	7,09		31,2	11,5		0,00			54		10,3													
		2000		10,5		0,00																		
ABS.COL.	7,50	2000	33,6	10,9					50		9,4													
ANOLYTE	8,35	2000	36,3	11,4		0,00			55	44,7	8,0	30		4,2		0,0	0,4	27,8	20,3	10,8				
CATHOLYTE										22,0		36,8				55,9	11,5	0,0	8,3	85,3				
ABS.COL.										60 + 60	8,6	15	4,5	1,5	3,0	0,0				4,7	40	3,5	6,8	15,4

AS TABLE 23

EXPERIMENT 5 : MICROFILTRATION

FEED: 60L FROM EXPERIMENT 5 CARBONATION, TOTAL FEED = 120L.

TIME	SAMPLE	VOL	PERM. RECOVERY	FLUX	SAMPLE ANALYSIS													POINT REJECTION (%)									
					pH	COND	TC	IC	OC	COD	Na	Ca	Mg	CO3=	HCO3-	TOT. CO2	TS	COND	TC	IC	OC	COD	Na	Ca	Mg	TOT. CO2	TS
(h-min)		(l)	(%)	(l/m2/h)		(mS/cm)	(g/l)	(g/l)	(g/l)	(g/l)	(g/l)	(mg/l)	(mg/l)	(g/l)	(g/l)	(g/l)	(g/l)										
0.00	FEED	60			9.3	19	6.3	1.5	4.8	6.6	6.3	50	5	13.8	0	10.1	19.6										
	PERM	0	0	1.9 @ 200KP 22C	8.9	19	3.8	2.2	1.6	0.7	6.3	23	8	2.6	9.1	8.5	16.9	1	40	0	67	90	0	54	0	16	14
20.00	PERM	20	33																								
40.00	PERM	50	83																								
ADDED A FURTHER 60L EFFLUENT FROM EXPERIMENT 5 CARBONATION.																											
64.00	PERM	70	58																								
112.00	PERM	100	83																								
136.00	PERM	105	88																								
AT THIS STAGE THE REMAINING LIQUOR WAS LOST DUE TO LEAKAGE IN THE PRESSURE PIPE.																											

COMMENTS: NOTE: EVAPORATIVE LOSS ABOUT 5L.

AS TABLE 24

EXPERIMENT 5 : NANOFILTRATION

FEED: 105L FROM EXPERIMENT 5 CROSS-FLOW MICROFILTRATION

TIME (h-min)	SAMPLE	VOL (l)	PERM. RECOVERY (%)	FLUX (l/m2/h)	SAMPLE ANALYSIS													POINT REJECTION (%)									
					pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	COD (g/l)	Na (g/l)	Ca (mg/l)	Mg (mg/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	TS (g/l)	COND	TC	IC	OC	COD	Na	Ca	Mg	TOT. CO2	TS
0.00	FEED	105			9.5	18		2		0.8	5.7	24	7	3.4	7.9	8.2	14.7										
	PERM	0	0	6.2	9.2	2	1.8	1	0.8	0.1	3.6	11	3	1.8	5.5	5.2	8.3	32		50		88	37	59	57	35	44
				@ 19C																							
2.50	PERM	10	10	8.5																							
				@ 39C																							
4.38	PERM	20	20	9.1																							
				@ 46C																							
6.30	PERM	30	29	9.1																							
				@ 48C																							
8.22	PERM	40	38	8.7																							
				@ 50C																							
10.20	PERM	50	48	5																							
				@ 51C																							
10.20	PERM	60	57	7.2																							
				@ 43C																							
11.20	PERM	70	67	10																							
				@ 50C																							
13.2	FEED	5			9.7	22	5.5	1.6	3.9	9	7.4	67.5	12	2.9	13.2	11.6	28										
	PERM	80	77	4.8	9.8	20	2.6	2.1	0.6	2	6.4	7	7.5	4.4	7.4	8.6	15.8	7	53	0	85	14	90	78	38	26	44
				@ 38C																							

COMMENTS: NOTE: EVAPORATIVE LOSS ABOUT 20L.

A5 TABLE 25

EXPERIMENT NO 5 : ELECTROLYSIS OF EFFLUENT SAMPLE A

ANOLYTE : 30 L FROM EXP 5 NF
CATHOLYTE : 15L NAOH
ABSORBTION COL : 30 L SCOUR EFFLUENT

SAMPLE	TIME (h-min)	CURRENT DENSITY (A/sq.m)	FARADAY PASSED (F)	VOLTAGE (V) OVERALL	CELL	MEMBRANE	C-M	A-M	TEMP. CELSIUS	VOLUME (l)	SAMPLE ANALYSIS pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	OH- (g/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	Na+ (g/l)	Ca++ (mg/l)	Mg++ (mg/l)	COD (g/l)	TS (g/l)
ANOLYTE	0,00	60	0,0	4,5					19	30,0	9,0	16,4	2,3	1,9	0,4	0,0	2,5	7,0	6,8	5,1	14,5	3	1,8	
CATHOLYTE		400		7,6						15,0		31,9				36,9	6,5	0,0	4,7	57,2				
ABS.COL.		800		10,2						30,0	13,3	40	3,3	0,1	3,2	0,0	1,0	1,1	0,8	5,6				
		1000		14,5	10,6	0,40	1,5	9,1																
	0,15	1000	0,2	15,8																				
		800		14,2																				
ANOLYTE	1,55	800	2,5	15,3					37	29,2	7,1	9,2	1,4	0,9	0,5	0,0	0,3	4,9	4,1	2,5				
CATHOLYTE										15,3						51,7	6,0	0,0	4,3	61,3				
ABS.COL.										30,0	13,1	27,2	4,0	0,7	3,3	0,8	5,0	0,0	3,6					
		600		12,8		0,20			37															
	2,42	600	3,5	15,5																				
		400		12,2																				
	3,30	400	3,9	15,1																				
		300		12		0,09																		
ABS.COL.	4,00	300	4,3	15					40		8,9													
		200		11,5		0,10																		
ABS.COL.	4,40	200	4,5	15,1							8,4													
		60		7,6																				
ANOLYTE		60	4,6	7,6		0,06			40	28,1	3,5	1,7	0,3	0,1	0,2	0,0	0,0	1,7	1,2	0,3	7	2	1,2	
CATHOLYTE										15,7		28,7				38,5	5,5	0,0	4,0	68,8				
ABS.COL.										30,0	9,4	16,9	5,0	1,9	3,1	0,0	2,2	8,9	3,0	5,6				

AS TABLE 26

EXPERIMENT NO 5 : ELECTROLYSIS OF EFFLUENT SAMPLE B

ANOLYTE : 30 L FROM EXP 5 NF
CATHOLYTE : 13 L FROM EXP 5 CELL A
ABSORBTION COL : 30 L FROM EXP 5 CELL A + 30 L SCOUR EFFLUENT

SAMPLE	TIME (h-min)	CURRENT DENSITY (A/sq.m)	FARADAY PASSED (F)	VOLTAGE (V) OVERALL	CELL	MEMBRANE	C-M	A-M	TEMP. CELSIUS	VOLUME (l)	SAMPLE ANALYSIS pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	OH- (g/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	Na+ (g/l)	Ca++ (mg/l)	Mg++ (mg/l)	COD (g/l)	TS (g/l)
ANOLYTE	0,00	60	0,0	4,9					16	30,0	9,1	13,3	1,7	0,8	0,9	0,0	2,3	5,0	5,3	4,3	14,5	3,5	0,8	
CATHOLYTE		400		8,1						13,0		21,8				33,8	5,0	0,0	3,6	52,1				
ABS.COL.		800		12,2						60,0	12,7	22,4	4,8	0,7	4,1	0,4	5,4	0,0	3,9	5,1				
		1000		14,7	8,3	0,03	1,5	6,2																
ABS.COL.	0,50	1000	1,2	15							11,2													
		800		12,7		0,10			27															
	1,40	800	2,5	15,4					37															
ABS.COL.		600		13,3		0,10					8,9													
	2,25	600	3,2	15,8		0,08																		
		400		14,1																				
ANOLYTE	2,39	400	3,4	15,5		0,08			40	28,6	4,1	2,9	0,6	0,3	0,3	0,0	0,2	1,3	1,1	0,7				
CATHOLYTE										13,7						48,9	4,6	0,0	3,3	59,2				
ABS.COL.										60,0	9,4	16,9	5,5	2,0	3,5	0,0	3,1	6,5	7,0	5,0				
		300	3,5	13,1		0,08																		
	2,55	300		15,3																				
		200		12,6																				
ABS.COL.	3,20	200	3,7	15					37		7,8													
		100		9,3																				
		60		7,7																				
ANOLYTE	4,30	60	3,8	8,8		0,08			38	28,4	2,7	1,2	0,3	0,0	0,3	0,0	0,0	1,0	0,7	0,3	2,5	1	1,2	
CATHOLYTE										15,5		25,7				36,7	3,6	0,0	2,6	62,6				
ABS.COL.										60,0	9,6	16,9	5,9	2,0		0,0	2,9	7,2	7,3	5,3				

AS TABLE 27

EXPERIMENT NO 5 : ELECTROLYSIS OF EFFLUENT SAMPLE C

ANOLYTE : 20 L FROM EXP 5 NF
CATHOLYTE : 12 L FROM EXP 5 CELL B
ABSORBTION COL : 20 L SCOUR EFFLUENT

SAMPLE	TIME (h-min)	CURRENT DENSITY (A/sq.m)	FARADAY PASSED (F)	VOLTAGE (V) OVERALL	CELL	MEMBRANE	C-M	A-M	TEMP. CELSIUS	VOLUME (l)	SAMPLE ANALYSIS pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	OH- (g/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	Na+ (g/l)	Ca++ (mg/l)	Mg++ (mg/l)	COD (g/l)	TS (g/l)
ANOLYTE	0,00	60	0,0	4,6					21	20,0	8,8	10,4	1,3	0,8	0,4	0,0	2,3	5,0	5,3	5,8	10,5	3	0,4	
CATHOLYTE		400		8,3						12,0		20,2				30,6	2,6	0,0	1,9	50,1				
ABS.COL.		800		12,1						20,0	13,2	42,3		0,2		2,3	2,2	0,0	1,6	5,6				
		1000		14,6	9,0	0,40	1,6	7,1																
	0,10	1000	0,1	15,1																				
		800		13,2		0,40																		
	1,15	800	1,7	15,1		0,20																		
		600		12,3		0,20																		
ANOLYTE	1,40	600	2,2	15,1		0,20			39	19,7	5,3	6,3	1,0	0,5	0,5	0,0	0,5	2,9	2,4	1,7				
CATHOLYTE										12,4						33,9	3,1	0,0	2,2	54,1				
ABS.COL.										20,0	10,8													
		400		11,2		0,20																		
ABS.COL.	2,10	400	2,5	15,1							9,6													
		200		9,4																				
ABS.COL.	2,52	200	2,8	15,3					43		10,6													
		60		7,8																				
ANOLYTE	4,00	100	2,9	11,4		0,10			45	19,2	2,1	1	0,2	0,0	0,2	0,0	0,0	0,5	0,4	0,3	1,3	0,4	0,7	
CATHOLYTE										12,7		24,2				31,3	8,4	0,0	6,0	56,4				
ABS.COL.										20,0	10,1	17,8	5,0	2,1	2,9	0,0	4,0	5,3	6,8	5,6				20,4

AS TABLE 28

EXPERIMENT NO 6 : CARBONATION

ANOLYTE : 50 L AT 40G/L NA_2CO_3 AND 50G/L $NAHCO_3$
CATHOLYTE : 15L NAOH
ABSORBTION COL : 60 L SCOUR EFFLUENT INITIALLY, TOTAL : 160 L.

SAMPLE	TIME (h-min)	CURRENT DENSITY (A/sq.m)	FARADAY PASSED (F)	VOLTAGE (V)					TEMP. CELSIUS	VOLUME (l)	SAMPLE ANALYSIS													
				OVERALL	CELL	MEMBRANE	C-M	A-M			pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	OH- (g/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	Na+ (g/l)	Ca++ (mg/l)	Mg++ (mg/l)	COD (g/l)	TS (g/l)
ANOLYTE	0,00	100	0,0	4,1					22	50,0	9,7	48		5,7		0,0	19,9	13,4	24,3	28,5	4	1,5		
CATHOLYTE		400		5,7						15,0		25,6				43,7	4,6	0,0	3,3	61,1				
ABS.COL.		1000		7,7						60,0	13,1	33,5	4,3	0,3	4,0	1,8	2,3	0,0	1,7	4,5	25	4,5	11,9	14,4
		1500		9,3																				
		2000		10,8																				
		2500	0,1	12,2	6,0	0,50	1,8	3,9																
ANOLYTE	3,46	2500	17,1	12		0,20			54	47,2	8,3	50,6		9,6		0,0	6,5	43,2	35,9	20,7				
CATHOLYTE										18,2						54,1	7,0	0,0	5,0	76,3				
ABS.COL.										60,0	12,5	16,2	3,6	0,7	2,9	0,0	5,2	0,4	4,1	4,4				
		2200		10,9		0,30																		
ANOLYTE	5,06	2200	21,9	11,1		0,00			54	46,7	8,2	47,4		10,1		0,0	5,5	40,1	33,0	20,0				
CATHOLYTE										18,9						62,1	5,3	0,0	3,8	76,7				
ABS.COL.										60,0	8,1	14,4	6,8	2,4	4,4	0,0	0,6	10,1	7,7	4,7				
ADDED 60 L SCOUR EFFLUENT TO ABSORPTION COLUMN																								
ANOLYTE	6,21	2200	27,7			0,00			56	35,6	8,1	42,4		2,2		0,0	4,6	33,3	27,4	17,5				
CATHOLYTE										19,6						57,5	6,2	0,0	4,5	78,7				
ABS.COL.										60 + 60	8,6	11	3,2	1,8	1,4	0,0	1,0	6,1	5,1	3,3				
ADDED 40 L SCOUR EFFLUENT TO ABSORPTION COLUMN																								
		2000		10,8																				
ANOLYTE	7,26	2000	31,8	11,1		0,00			55	44,7	8,1	34,8		3,3		0,0	3,4	18,5	16,1	12,8	2	1		
CATHOLYTE										20,1		44,1				61,4	6,2	0,0	4,5	79,2				
ABS.COL.										120 + 40	8,7	9,6	2,7	1,4	1,3	0,0	1,4	3,7	3,7	2,7	26,5	5	5,2	10,7

AS TABLE 29a

EXPERIMENT 6: MICROFILTRATION

FEED: 160L FROM EXPERIMENT 6 CARBONATION

TIME (h-min)	SAMPLE	VOL (l)	PERM. RECOVERY (%)	FLUX (l/m2/h)	SAMPLE ANALYSIS pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	COD (g/l)	Na (g/l)	Ca (mg/l)	Mg (mg/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	TS (g/l)	POINT REJECTION (%) COND	TC	IC	OC	COD	Na	Ca	Mg	TOT. CO2	TS
0.00	FEED	160			8.6	17		2		11.8	5.2	22	8	2	5.1	5.1	17										
	PERM	0	0	1.4	7.8	10	2.6	1.5	1.1	4.5	2.7	28	5	1.7	3.8	4	9.3	45		25		38	48	0	38	22	45
				@ 200KP																							
				17C																							
4.40	PERM	2	1																								
19.20	PERM	17	11																								
28.40	PERM	40	25																								
47.50	RAN AT 160KPa																										

COMMENTS:

COMPANY:

AS TABLE 29b

EXPERIMENT 6: NANOFILTRATION

FEED: 40L FROM EXPERIMENT 6 CROSS-FLOW MICROFILTRATION

TIME (h-min)	SAMPLE	VOL (l)	PERM. RECOVERY (%)	FLUX (l/m2/h)	SAMPLE ANALYSIS pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	COD (g/l)	Na (g/l)	Ca (mg/l)	Mg (mg/l)	$CO_3^{=}$ (g/l)	HCO_3^- (g/l)	TOT. CO_2 (g/l)	TS (g/l)
0.00	FEED	40		1,6MPa	9.1	13		1.8		1.9	2.9	21	6	1.9	5.6	5.5	11
	PERM	0	0	6.1	9	9	1.3	0.9	0.4	0.3	2.4	6	3	1.7	3.1	3.5	6.1
2.25	PERM	10	25	8.7													
				@ 42C													
4.05	PERM	20	50	9.9													
				@50C													
6.15	PERM	30	75	9.6													
				@ 57C													
7.05	FEED	5			9.7	26	10.3	3.8	6.5	21.8	9.6	122	40	4.6	11.8	11.9	41.5
	PERM	35	88	4.9	9.6	22	4	2.3	1.7	3.3	7.1	19	14	3.1	9.9	9.4	21.2
				@ 1,2MP 50C													

TIME (h-min)	SAMPLE	POINT REJECTION (%) COND	TC	IC	OC	COD	Na	Ca	Mg	TOT. CO_2	TS
0.00	FEED										
	PERM	30		50		84	48	29	50	36	55
7.05	FEED										
	PERM	16	61	40	74	85	26	84	65	21	49

COMMENTS:

COMPANY:

AS TABLE 30

EXPERIMENT NO 7 : CARBONATION

ANOLYTE : 50 L AT 40G/L NA2CO3 AND 50G/L NAHCO3
CATHOLYTE : 15L NAOH
ABSORPTION COL : 60 L SCOUR EFFLUENT INITIALLY, TOTAL = 120 L

SAMPLE	TIME (h-min)	CURRENT DENSITY (A/sq.m)	FARADAY PASSED (F)	VOLTAGE (V) OVERALL	CELL	MEMBRANE	C-M	A-M	TEMP. CELSIUS	VOLUME (l)	SAMPLE ANALYSIS pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	OH- (g/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	Na+ (g/l)	Ca++ (mg/l)	Mg++ (mg/l)	CuO (g/l)	[illegible] (g/l)
ANOLYTE	0,00	60		4,3					26	50,0	9,4	61,8		9,0		0,0	21,0	25,1	33,5	28,8	4	1,4	0,1	
CATHOLYTE		400		5,9						15,0		16,8				21,1	3,4	0,0	2,4	20,5				
ABS.COL.		1000		8,4						60,0	13,4	68,7	3,3	0,1	3,1	4,4	2,2	0,0	1,6	9,4				
		1700		10,9																				
		2000		11,8																				
		2500		13,3	7,0	0,20	2,0	4,1																
ANOLYTE	2,20	2500	11,2	11,3		0,30			52	40,6	8,7	52,5		9,0		0,0	13,2	29,2	30,7	23,2				
CATHOLYTE										16,5						32,4	3,4	0,0	2,4	45,9				
ABS.COL.										60,0	13,4	62,1	3,3	0,3	3,0	3,2	3,5	0,0	2,5	8,6				
		2200		10,2		0,30																		
ANOLYTE	5,00	2200	21,7	12		0,20			55	46,1	8,4	42		0,1		0,0	7,7	26,8	25,0	16,7				
CATHOLYTE										18,0						37,1	6,2	0,0	4,5	61,6				
ABS.COL.										60,0	9,5	24,4	7,3	3,9	3,4	0,0	4,2	12,6	12,2	8,7				
ADDED FURTHER 60 L SCOUR EFFLUENT TO ABSORPTION COLUMN																								
		2000		11																				
ANOLYTE	6,00	2000	25,7	11,4		0,20			57	45,0		36,2		5,7		0,0	6,2	19,5	18,6	13,7				
CATHOLYTE										18,6						53,5	5,0	0,0	3,6	69,5				
ABS.COL.										60 + 60	8,6	24,2	8,0	4,1	3,9	0,0	3,6	12,3	11,5	8,7				
	7,00	2000	29,4	11,8					58															
		1900		11,6																				
ABS.COL.	8,45	1900	35,7	13,6					60		9,7													
	9,10	1900	36,6	14,1																				
		1500		11,4					58															
ANOLYTE	10,15	1500	40,5	13,4	5,2	0,20	1,2	6,5		41,2	8,0	15,5		2,4		0,0	2,8	7,0	7,1	4,9	1	0,5	0,1	
					7,9																			
CATHOLYTE										20,3		30,5				51,8	4,8	0,0	3,5	87,6				
ABS.COL.										60 + 60	8,1	24,4	8,3	4,3	4,0	0,0	1,9	16,1	13,0	9,1				

AS TABLE 31

EXPERIMENT 7: MICROFILTRATION

FEED: 60L FROM EXPERIMENT 7 CARBONATION, TOTAL FEED = 120L.

TIME (h-min)	SAMPLE	VOL (l)	PERM. RECOVERY (%)	FLUX (l/m2/h)	SAMPLE ANALYSIS													POINT REJECTION (%)									
					pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	COD (g/l)	Na (g/l)	Ca (mg/l)	Mg (mg/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	TS (g/l)	COND	TC	IC	OC	COD	Na	Ca	Mg	TOT. CO2	TS
0.00	FEED	60			8.4	21.5	6.8	3.8	3	4.9	7	37	4.2	3.3	11.8	10.9	18.8										
	PERM	0	0	3.6 @ 25C	9	22.5	5.3	2.5	2.8	2.3	6.9	18	2.5	3.8	11.7	11.2	18.4	0	22.1	34.2	6.7	53.1	1.4	51.4	40.5	0	2.1
11.00	FEED	10			9.2	23.2	11.8	3	8.8	22.1	8.9	18.5	14	4.4	13.7	13.1	30.1										
	PERM	100	83	2 @ 29C	9.4	25.2	6.9	2.1	4.8	3.2	8.6	17.5	2	5.4	11.8	12.5	21.7	0	41.5	30	45.5	3.4	85.5	5.4	85.7	4.6	27.9

COMMENTS: AT THIS STAGE ADJUSTMENTS TO THE PUMP TO INCREASE ITS PUMPING SPEED WERE MADE AND THE EFFLUENT FROM CARBONATION WAS TRANSFERRED DIRECTLY TO NANOFILTRATION.

NOTE: EVAPORATIVE LOSS ABOUT 5L.

AS TABLE 32

EXPERIMENT 7 : NANOFILTRATION

FEED; 60L FROM EXPERIMENT 7 CARBONATION, TOTAL FEED = 100L.

TIME (h-min)	SAMPLE	VOL (l)	PERM. RECOVERY (%)	FLUX l/m2/h @ 1,6MP	SAMPLE ANALYSIS													POINT REJECTION (%)									
					pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	COD (g/l)	Na (g/l)	Ca (mg/l)	Mg (mg/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	TS (g/l)	COND	TC	IC	OC	COD	Na	Ca	Mg	TOT. CO2	TS
THIS FEED WAS NOT CROSS-FLOWED.																											
0.00	FEED	60			9.2	25	5.5	1.1	4.4	5.5	8.6	34.5	3	3.5	14.6	13.1	21.3										
	PERM	0	0	6.2	8.9	20	4.4	2.4	2	0.4	6.5	10	1.2	0.7	15.1	11.4	14.9	19	20	0	55	93	24	71	60	13	30
2.25	PERM	10	17	7.4 @ 40C																							
4.40	PERM	20	33	6.7 @ 50C																							
	PERM	30	50	6.4 @ 50C																							
	FEED	20			9.1	31	11.9	4.5	7.4	16.5	11.3	97.5	10	2.9	22.4	18.3	34.2										
	PERM	40	67	5.3 @ 50C	8.9	25	4.8	3.9	0.9	1.4	8.8	15	2	1.3	21.2	16.2	20.2	17	60	13	88	92	21	85	80	12	41
THE RIG WAS DRAINED AND FLUSHED WITH DEIONISED WATER.																											
THIS FEED WAS CROSS-FLOWED.																											
0				5.6 @22C																							
1.45	FEED			5.6	9.4	41	19.7	4.5	15.2	27.8	17.7	95.5	15	9.7	22.2	23.1	54.7										
	PERM				9.2	31	8.1	2.5	5.6	3.5	11.3	11	2	5.6	16.1	15.7	27.1	24	59	44	63	87	36	89	87	32	51
THE RIG WAS DRAINED AND FLUSHED WITH DEIONISED WATER																											
0	FEED				9.2	23	4.8	1.5	3.3	3.4	8.1	24	2	3.2	12.2	11.1	19.7										
	PERM			5.5 @ 21C	9.3	16	2.8	1.2	1.6	0.6	5.2	10	1.3	2.8	7.3	7.3	10.4	31	42	20	52	82	36	58	35	34	47
1.45	FEED	5			9.3	31	9.6	3.8	5.8	7.9	11.6	31.5	3.3	5.2	16.7	15.9	28.5										
	PERM	75	75	7.2 @ 55C	9.3	23	4.7	3.4	1.3	1	8.4	13.4	1.5	3.6	11.6	11	18.3	25	51	11	78	87	28	58	45	31	36

NOTE: EVAPORATIVE LOSS ABOUT 20L.

AS TABLE 33

EXPERIMENT NO 7 : ELECTROLYSIS OF EFFLUENT SAMPLE A

ANOLYTE : 25 L FROM EXP 7 NF
CATHOLYTE : 15 L AT 200G/L NAOH
ABSORBTION COL : 25 L SCOUR EFFLUENT

SAMPLE	TIME (h-min)	CURRENT DENSITY (A/sq.m)	FARADAY PASSED (F)	VOLTAGE (V) OVERALL	CELL	MEMBRANE	C-M	A-M	TEMP. CELSIUS	VOLUME (l)	SAMPLE ANALYSIS pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	OH- (g/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	Na+ (g/l)	Ca++ (mg/l)	Mg++ (mg/l)	COD (g/l)	TS (g/l)
ANOLYTE	0,00	60		4,1					23	25,0	8,7	15,8	3,5	1,2	2,3	0,0	3,2	6,3	6,9	5,2	8	1		
CATHOLYTE		400		6,7						15,0		47,3				67,7	5,3	0,0	3,8	93,1				
ABS.COL.		800		8,5						25,0	13,0	35,2	2,3	0,1	2,2	2,4	1,9	0,0	1,4	4,6				
		1200		12,2	10,3	0,20	1,6	8,5																
	0,10	1200		15,1																				
		1000		13,4		0,18																		
ABS.COL.	1,55	1000	3,2	15,1					50		11,2													
		800		11,9		0,09																		
ANOLYTE	2,35	800	4,3	15,5		0,10			49	14,7	5,9			0,1		0,0	1,6	1,2	2,0	1,9				
CATHOLYTE										15,8						69,8	9,1	0,0	6,6	100,3				
ABS.COL.										25,0	9,8	11,9	3,3	1,3	2,0	0,0	4,4	2,2	4,8					
		600		12,8																				
	3,00	600	4,8	15,5					52															
		400		12		0,10																		
	3,25	400	5,1	15,3		0,10			51															
ANOLYTE	3,45	300	5,3	15,2		0,13			50	13,5	4,4	1,6	0,4	0,0	0,4	0,0	0,0	0,5	0,4	0,4	3	0		
CATHOLYTE										15,3		36,7				94,6	6,5	0,0	4,7	104,4				
ABS.COL.										25,0	8,9	14,1	4,6	1,7	2,9	0,0	2,5	7,3	7,1					
		60		7,7		0,10																		

AS TABLE 34

EXPERIMENT NO 7 : ELECTROLYSIS OF EFFLUENT SAMPLE B

ANOLYTE : 25 L FROM EXP 7 NF
CATHOLYTE : 15 L FROM EXP 7 CELL A
ABSORBTION COL : 25 L FROM EXP 7 CELL A AND 25 L SCOUR EFFLUENT

SAMPLE	TIME (h-min)	CURRENT DENSITY (A/sq.m)	FARADAY PASSED (F)	VOLTAGE (V) OVERALL	CELL	MEMBRANE	C-M	A-M	TEMP. CELSIUS	VOLUME (l)	SAMPLE ANALYSIS pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	OH- (g/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	Na+ (g/l)	Ca++ (mg/l)	Mg++ (mg/l)	COD (g/l)	TS (g/l)
ANOLYTE	0,00	60	0,0	4,3					23	25,0	8,0	19	3,3	2,2	1,1	0,0	3,5	7,3	7,8	5,9	12	1		
CATHOLYTE		600		8,2						15,0		50				60,0	5,5	0,0	4,0	87,0				
ABS.COL.		1200		15,9	11,2	0,20	1,8	9,8		50,0	12,8	24	4,0	0,7	3,3	0,2	6,2	0,0	4,5	5,3				
		1000		14		0,10																		
ABS.COL.	1,45	1000	3,0	15					42		10,4													
		800	3,5	12,2		0,10																		
		600		12,1																				
ANOLYTE	2,00	600	3,5	12,1		0,20			41	15,1	7,3	10	2,2	0,7	1,5	0,0	1,9	2,8	3,4	2,8				
CATHOLYTE										15,4						58,5	6,0	0,0	4,3	85,3				
ABS.COL.										50,0	10,3	17,3	4,3	1,3	3,0	0,0	5,3	2,8	5,9					
	2,20	600	3,8	15,1																				
ABS.COL.		400		11		0,20			42		10,0													
ANOLYTE	3,00	400	4,3	15																				
ABS.COL.		300		12,1		0,17			46		9,8													
ANOLYTE	3,30	300	4,6	15,6	14,0	0,25	1,1	12,6		10,3	6,1	2,3	0,4	0,1	0,4	0,0	0,2	1,5	1,2	0,5	0,7	0,1		
CATHOLYTE										15,5		34,8				64,9	3,1	0,0	2,2	95,2				
ABS.COL.										50,0	10,1	17,5	4,3	1,9	2,4	0,0	4,4	4,0	6,1					

* NOTE: APPROX. 15 L LOST THROUGH LEAKAGE OF ANOLYTE PIPE.

DATE:

A5 TABLE 35

EXPERIMENT NO 7 : ELECTROLYSIS OF EFFLUENT SAMPLE C

ANOLYTE : 25 L FROM EXP 7 NF
CATHOLYTE : 15 L FROM EXP 7 CELL 8
ABSORBTION COL : 25 L SCOUR EFFLUENT

SAMPLE	TIME	CURRENT DENSITY	FARADAY PASSED	VOLTAGE (V)					TEMP. CELSIUS	VOLUME	SAMPLE ANALYSIS													
	(h-min)	(A/sq.m)	(F)	OVERALL	CELL	MEMBRANE	C-M	A-M		(l)	pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	OH- (g/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	Na+ (g/l)	Ca++ (mg/l)	Mg++ (mg/l)	COD (g/l)	TS (g/l)
ANOLYTE	0,00	60	0,0	4,7					23	25,0	8,7	20,3	4,6	2,8	1,8	0,0	4,4	5,9	7,5	6,7	9,5	1,2		
CATHOLYTE		400		6,9						15,0		42,2				49,4	4,6	0,0	3,3	64,1				
ABS.COL.		1000		11,8						25,0	12,8	45	3,6	0,2	3,4	2,1	4,3	0,0	3,1	6,6				
	0,08	1200	0,1	14,9	9,6	0,13	1,6	7,9																
		1200	0,1	15,1																				
		1000		13,1																				
ABS.COL.	1,15	1000	2,2	15					39		12,3													
		800		12,2																				
ABS.COL.	2,15	800	3,6	15					43		10,4													
		600		11,7		0,15																		
ANOLYTE	3,05	600	4,6	15					40	14,1	7,1	8,8	2,3	0,6	1,7	0,0	1,8	2,6	3,2	3,0				
CATHOLYTE										15,7						45,1	6,0	0,0	4,3	67,5				
ABS.COL.										25,0	9,7	10	5,0	1,9	3,1	0,0	5,4	3,8	6,7					
		400		10,8		0,25																		
ANOLYTE	3,30	400	4,9	15,1	8,0	0,25	1,2	6,5	40	13,6	6,5	5	1,1	0,0	1,1	0,0	0,4	1,6	1,4	1,3	0	1		
CATHOLYTE										15,8		40				43,4	6,5	0,0	4,7	62,6				
ABS.COL.										25,0	9,3	21	6,0	1,9	4,1	0,0	4,6	7,0	8,4					

EXPERIMENT STOPPED DUE TO LACK OF ANOLYTE LIQUOR. ABOUT 5 L WAS LEFT IN THE TANK AND ABOUT 15 L LOST DUE TO LEAKAGE.

AS TABLE 36

EXPERIMENT NO 8 : CARBONATION

ANOLYTE : 50 L AT 112G/L NAOH
CATHOLYTE : 15L NAOH
ABSORBTION COL : 60 L SCOUR EFFLUENT INITIALLY (+60 L).

SAMPLE	TIME (h-min)	CURRENT DENSITY (A/sq.m)	FARADAY PASSED (F)	VOLTAGE (V)					TEMP. CELSIUS	VOLUME (l)	SAMPLE ANALYSIS													
				OVERALL	CELL	MEMBRANE	C-M	A-M			pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	OH- (g/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	Na+ (g/l)	Ca++ (mg/l)	Mg++ (mg/l)	COD (g/l)	TS (g/l)
ANOLYTE	0,00	60	0,0	4,4					22	50,0	8,2	62		4,5		0,0	10,6	26,0	26,5	27,3				
CATHOLYTE		600		7,2						15,0		21,9				39,2	4,6	0,0	3,3	54,3				
ABS.COL.		1500		10,4						60,0	13,1	49,6	2,5	0,1	2,4	2,9	2,4	0,0	1,7	6,1	30	3,5	6,6	15,8
		2500		14,1	7,6	0,50	1,8	5,3																
ANOLYTE	2,55	2500	13,4	11		0,20			49	45,2	7,9	50,5		7,8		0,0	12,7	27,3	28,8	21,2				
CATHOLYTE										17,5						47,6	2,2	0,0	1,6	67,1				
ABS.COL.										60,0	8,8	20,2	5,5	0,6	4,9	0,0	1,3	13,3	10,5					
ADDED FURTHER 60 L SCOUR EFFLUENT TO ABSORPTION COLUMN.																								
		2000		9,4		0,20																		
ANOLYTE	5,32	2000	23,1	9,7	5,0	0,18	1,5	3,3	53	43,6	8,0	44,7		6,9		0,0	8,5	28,7	26,9	15,8				
CATHOLYTE										18,9		30,6				57,3	4,3	0,0	3,1	70,6				
ABS.COL.										60 + 60	8,5	16,9	4,6	1,7	2,9	0,0	0,8	11,1	8,6	5,2	28,5	3	4,0	13,2

AS TABLE 37

EXPERIMENT 8: MICROFILTRATION

FEED: 120 L FROM EXPERIMENT 8 CARBONATION

TIME	SAMPLE	VOL	PERM.	FLUX	SAMPLE ANALYSIS													POINT REJECTION (%)									
(h-min)		(l)	RECOVERY (%)	(l/m2/h)	pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	COD (g/l)	Na (g/l)	Ca (mg/l)	Mg (mg/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	TS (g/l)	COND	TC	IC	OC	COD	Na	Ca	Mg	TOT. CO2	TS
0.00	FEED	120			8.9	18	5.3	2.1	3.2	5.3	5.8	32.5	3.1	2.7	7.7	7.5	15.1										
	PERM	0	0	61.50	8.7	18	4.9	1.4	3.5	3.3	5.6	21.5	3.0	3.2	6.8	7.3	14.0	0	8	33	0	3	38	34	3	3	7
				@ 300KP																							
				24C																							
12.50	PERM	10	8																								
24.05	PERM	25	21																								
91.10	FEED	10			9.5	19	11.9	2.3	9.6	50.0	7.1	175.0	11.0	0.5	16.3	12.1	32.4										
	PERM	100	83		9.4	20	6.1	1.9	4.2	5.6	6.6	18.5	3.0	3.2	8.9	8.8	16.9	0	49	17	56	7	89	89	73	27	48

COMMENTS: EVAPORATIVE LOSS 10L

AS TABLE 38

EXPERIMENT 8: NANOFILTRATION

FEED: 50 L FROM EXPERIMENT 8 CFMF

TIME (h-min)	SAMPLE	VOL (l)	PERM. RECOVERY (%)	FLUX (l/m2/h)	SAMPLE ANALYSIS pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	COD (g/l)	Na (g/l)	Ca (mg/l)	Mg (mg/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	TS (g/l)	POINT REJECTION (%) COND	TC	IC	OC	COD	Na	Ca	Mg	TOT. CO2	TS
0.00	FEED	50			8.8	19	4.5	1.6	2.9		5.7	22.0	4.0	4.1	6.1	7.4	14.5										
	PERM			6.10	8.9	13	2.1	1.1	1.0		3.8	11.0	2.0	1.7	5.7	5.4	8.7	32	53	31	66	33		50	50	27	40
				@ 18C																							
2.22	PERM	10	20	8.60																							
				@ 38C																							
4.10	PERM	20	40	9.60																							
				@ 44C																							
5.50	PERM	30	60	8.80																							
				@ 47C																							
8.05	PERM	40	80	8.60																							
				@ 47C																							
8.25	AT THIS STAGE 50L OF CROSS-FLOW MICROFILTRATE WAS ADDED TO THE TANK																										
13.25	FEED	100			9.2	24	6.4			8.5		31.0	8.0	4.0	10.9	10.8											
	PERM	40	40	7.10	9.3	17	3.0			5.4		12.0	2.0	2.9	6.8	7.0		28	53			37		61	75	35	
				@ 1.8MP 40C																							
21.05	FEED	5			9.7	42	19.3	2.2	17.1	18.0	45.3	82.0	43.0	11.6	18.4	21.8	70.0										
	PERM	90	90	5.60	9.5	32	7.8	3.4	4.4	11.7	6.1	16.5	7.0	7.4	12.4	14.4	27.9	24	60	0	74	35	87	80	84	34	60
				@ 47C																							

COMMENTS: EVAPORATIVE LOSS 5L

AS TABLE 39

EXPERIMENT NO 8 : ELECTROLYSIS OF EFFLUENT SAMPLE A

ANOLYTE : 25 L FROM EXP 8 MF
CATHOLYTE : 15 L AT 200G/L NAOH
ABSORBTION COL : 25 L RAW SCOUR EFFLUENT

SAMPLE	TIME (h-min)	CURRENT DENSITY (A/sq.m)	FARADAY PASSED (F)	VOLTAGE (V) OVERALL	CELL	MEMBRANE	C-M	A-M	TEMP. CELSIUS	VOLUME (l)
ANOLYTE	0,00	60	0,0	4,5					22	25,0
CATHOLYTE		600		7,4						15,0
ABS.COL.		1200		11,3	6,8	0,25	1,2	5,3		25,0
ABS.COL.	0,40	1200	1,3	15					33	
		1000		12,8						
ABS.COL.	1,50	1000	3,4	15,1		0,10			40	
		800		12,6		0,10				
	3,00	800	5,1	15						
ABS.COL.		600		12		0,10			38	
ANOLYTE	3,30	600	5,8			0,01			35	23,3
CATHOLYTE										15,5
ABS.COL.										25,0
		400		10,7		0,10				
ANOLYTE	5,50	400	8,1	15		0,10			39	23,4
CATHOLYTE										15,6
ABS.COL.									10	25,0

SAMPLE	SAMPLE ANALYSIS pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	OH- (g/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	Na+ (g/l)	Ca++ (mg/l)	Mg++ (mg/l)	COD (g/l)	TS (g/l)
ANOLYTE	8,1	24,8	4,9	2,5	2,4	0,0	7,7	7,4	11,0	8,2	14	3		
CATHOLYTE		47,8				67,6	1,7	0,0	1,2	92,0				
ABS.COL.	12,9	68,8	2,9	0,3	2,6	4,6	2,5	0,0	1,8	9,0	34,4	5	9,7	25,0
ABS.COL.	12,4													
ABS.COL.	12,3													
ABS.COL.	11,8													
ANOLYTE	6,9		3,7	0,5	3,2	0,0	0,1	6,6	4,8	3,3				
CATHOLYTE						79,9	7,0	0,0	5,0	103,9				
ABS.COL.	11,2		6,1	1,1	5,0	0,0	10,0	0,7	7,8					
ANOLYTE	7,1	12,1	2,8	0,5	2,3	0,0	0,8	6,5	5,3	3,3	13	2,3	4,3	9,3
CATHOLYTE		39,2				71,8	5,8	0,0	4,2	102,0				
ABS.COL.	10,4	26,8	5,6	2,1	3,5	0,0	10,3	0,7	8,1					

AS TABLE 40

EXPERIMENT NO 8 : ELECTROLYSIS OF EFFLUENT SAMPLE B

ANOLYTE : 25 L FROM EXP 8 HF
CATHOLYTE : 15L NAOH
ABSORBTION COL : 25 L FROM EXP 8 CELL A + 25 L RAW SCOUR EFFLUENT

SAMPLE	TIME	CURRENT DENSITY	FARADAY PASSED	VOLTAGE (V)					TEMP. CELSIUS	VOLUME	SAMPLE ANALYSIS													
	(h-min)	(A/sq.m)	(F)	OVERALL	CELL	MEMBRANE	C-M	A-M		(l)	pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	OH- (g/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	Na+ (g/l)	Ca++ (mg/l)	Mg++ (mg/l)	COD (g/l)	TS (g/l)
ANOLYTE	0,00	60	0,0	5					19	25,0	8,3	16,6	3,6	2,7	0,9	0,0	3,4	5,1	6,2	5,3	12	3		
CATHOLYTE		600		8,5						15,0		35				64,9	4,1	0,0	3,0	85,0				
ABS.COL.		1200		14,2	8,5	0,05	1,6	7,0		50,0	12,8	51,1	3,4	0,8	2,6	2,4	5,4	0,0	3,9	8,6	30	4,3	8,5	
		1200		15,1																				
	0,11	1200	0,3	15,1																				
		1000		13,1		0,06																		
	0,54	1000	1,5	15,2																				
		800		12,7		0,08			35															
ABS.COL.	2,19	800	3,3	15,1					40		11,9													
		600		12,5																				
ANOLYTE	3,07	600	4,4	15,3		0,14			48	23,7	6,6		1,5	0,3	1,2	0,0	0,6	2,6	2,3	1,6			1,3	
CATHOLYTE										15,5						63,1	4,1	0,0	3,0	87,9				
ABS.COL.										50,0	11,2		5,9	2,1	3,8	0,0	9,8	2,8	9,2					
		400		11,9		0,13																		
	3,59	400	5,0	15,5																				
ABS.COL.		300		14,7		0,15			46		9,7													
ANOLYTE	4,09	300	5,1	15,4	10,0	0,16	1,1	8,7		23,1	3,6	1,2	0,3	0,0	0,3	0,0	0,0	0,4	0,3	0,2	2,5	0,3	1,1	
CATHOLYTE										15,6		34,7				60,5	3,6	0,0	2,6	88,6				
ABS.COL.										50,0	9,7													

AS TABLE 41

EXPERIMENT NO 8 : ELECTROLYSIS OF EFFLUENT SAMPLE C

ANOLYTE : 35 L FROM EXP 8 NF
CATHOLYTE : 15L NAOH
ABSORBTION COL : 25 L FROM EXP 8 CELL B + 35 L RAW SCOUR EFFLUENT

SAMPLE	TIME	CURRENT DENSITY	FARADAY PASSED	VOLTAGE (V)					TEMP. CELSIUS	VOLUME	SAMPLE ANALYSIS													
	(h-min)	(A/sq.m)	(F)	OVERALL	CELL	MEMBRANE	C-M	A-M		(l)	pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	OH- (g/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	Na+ (g/l)	Ca++ (mg/l)	Mg++ (mg/l)	COD (g/l)	TS (g/l)
ANOLYTE	0,00	60	0,0	4,4						35,0	9,1	17	3,1	2,7	0,4	0,0	3,0	6,0	6,5	5,3	10,5	2		
CATHOLYTE		600		8,8						15,0		26,8				43,3	3,6	0,0	2,6	62,5				
ABS.COL.		1200		14,2	5,9	0,50	1,0	4,2	18	60,0	12,6	36,9	3,6	1,5	2,1	1,2	7,6	0,0	5,5	8,1	20,2	3		
					9,6	0,18	1,7	8,5																
	0,10	1200	0,2	15,8																				
		1000		14,5		0,72																		
						0,66																		
ABS.COL.	1,50	1000	3,2	15					45		11,8													
		800		12,1		0,52																		
						0,11																		
ABS.COL.	2,40	800	4,5	15,1					47		11,0													
		600		11,4		0,43																		
						0,17																		
ANOLYTE	3,42	600	5,5	15,1					50	33,8	6,5		1,5	0,5	1,0	0,0	0,7	1,6	1,7	1,7				
CATHOLYTE										15,8						42,1	2,2	0,0	1,6	69,3				
ABS.COL.										60,0	9,7		10,6	3,3	7,3	0,0	7,4	5,1	9,1					
		400		11,2		0,36																		
						0,23																		
ABS.COL.	5,05	400	6,6	15,5					50		9,1													
		300		12,6		0,36																		
						0,28																		
ANOLYTE	5,40	300	6,9	15,3	6,6	0,40	0,8	5,5	48	33,5	5,4	1,9	0,7	0,0	0,7	0,0	0,0	0,5	0,4	0,4	0,8	0,3	0,8	
					10,0	0,33	1,0	8,5																
CATHOLYTE										15,9		30,9				42,9	4,1	0,0	3,0	71,1				
ABS.COL.										60,0														

A5 TABLE 42

EXPERIMENT NO 9 : CARBONATION

ANOLYTE : 50 L AT 112G/L NAHCO3
CATHOLYTE : 15L NAOH
ABSORBTION COL : 25 L FROM EXP 7 CELL C + 35 L RAW SCOUR EFFLUENT INITIALLY, TOTAL = 120 L

SAMPLE	TIME (h-min)	CURRENT DENSITY (A/sq.m)	FARADAY PASSED (F)	VOLTAGE (V) OVERALL	VOLTAGE (V) CELL	VOLTAGE (V) MEMBRANE	VOLTAGE (V) C-M	VOLTAGE (V) A-M	TEMP. CELSIUS	VOLUME (l)	SAMPLE ANALYSIS pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	OH- (g/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	Na+ (g/l)	Ca++ (mg/l)	Mg++ (mg/l)	COD (g/l)	TS (g/l)
ANOLYTE	0,00	60	0,0	4,5						50,0	8,1	53,5				0,0	16,1	19,9	26,2	27,8				
CATHOLYTE		1000		9,3						15,0		20,3				38,3	1,5	0,0	1,1	60,1				
ABS.COL.		2000		13,3						60,0	12,6	33,9	4,0	0,5	3,5	1,3	6,1	0,0	4,4	7,5	36	5,1	6,1	
		2500	0,3	15,4	8,0	0,50	1,5	5,5	22															
ANOLYTE	1,40	2500	7,3	12,4		0,60			38	48,6	7,2													
CATHOLYTE										16,3														
ABS.COL.										60,0	8,8	25	6,3	3,2	3,1	0,0	3,2	11,0	10,3	7,0				
ANOLYTE	3,50	2500	8,5	12	6,6	0,62	1,3	4,7	48	47,8	7,2	57,8				0,0	16,9	26,9	31,8	25,2				
CATHOLYTE										16,3						41,7	1,5	0,0	1,1	61,4				
ABS.COL.										60,0	8,6	22,1	7,5	3,6	3,9	0,0	2,2	13,1	11,1					
ADDED FURTHER 60 L SCOUR EFFLUENT TO ABSORPTION COLUMN. TRANSFERRED INITIAL 60 L TO CROSS-FLOW MICROFILTER.																								
ANOLYTE	5,30	2500	25,1	12,6	6,9	0,30	1,5	5,1	53	44,2		46,3				0,0	12,1	21,7	24,5	17,9				
CATHOLYTE										18,5		29,2				52,7	1,5	0	1,1	75,9				
ABS.COL.										60+60	9,1	25,4	7,8	4,6	3,2	0	3,8	13,5	12,5	8,4				

AS TABLE 43

EXPERIMENT 9: MICROFILTRATION

FEED: 120 L FROM EXPERIMENT 9 CARBONATION

TIME	SAMPLE	VOL	PERM.	FLUX	SAMPLE ANALYSIS													POINT REJECTION (%)									
(h-min)		(l)	RECOVERY (%)	(l/m2/h)	pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	COD (g/l)	Na (g/l)	Ca (mg/l)	Mg (mg/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	TOT. SOL (g/l)	COND	TC	IC	OC	COD	Na	Ca	Mg	TOT. CO2	TS
0.00	FEED	120			9.0	27	6.7	3.2	3.5	4.6	7.0	44.0	4.0	3.5	9.5	9.4	18.7										
	PERM			2.70	9.1	25	3.8	1.9	1.9	2.4	7.0	19.0	3.4	3.2	11.0	10.3	18.0	8	40	41	46	48	0	57	15	0.00	4.00
				@ 300KP																							
43.35	PERM	15	13																								
55.05	PERM	25	21																								
	PERM	42	35																								
78.05	PERM	52	43																								
140.15	FEED	10			9.5	41	25.7	5.5	20.2	39.0	17.2	213.0	41.0	11.2	19.3	22.1	69.1										
	PERM	75	63		9.7	35	8.0	4.6	3.4	5.3	12.1	9.0	3.3	10.8	8.9	14.3	33.5	14	69	16	83	86	30	96	92	35.00	52.00

COMMENTS: EVAPORATIVE LOSS 35L COMPANY:

AS TABLE 44

EXPERIMENT 9: NANOFILTRATION

FEED: 75L FROM EXP 9 CROSS-FLOW MICROFILTRATION

TIME (h-min)	SAMPLE	VOL (l)	PERM. RECOVERY (%)	FLUX (l/m2/h)	SAMPLE ANALYSIS														POINT REJECTION (%)									
					pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	COD (g/l)	Na (g/l)	Ca (mg/l)	Mg (mg/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	TS (g/l)	COND	TC	IC	OC	COD	Na	Ca	Mg	TOT. CO2	TS
0.00	FEED	75			9.1	24	4.1	2.0	2.1	2.1	7.4	22.0	3.0	3.2	12.6	11.4	19.1										
	PERM	0	0	6.6	9.2	19	1.2	0.5	0.7	0.4	5.9	12.0	2.0	3.2	9.0	8.8	13.5	21	71	75	67	90	20	46	33	23	29
				@ 18C																							
2.20	FEED	65																									
	PERM	10	13	9.2																							
				@ 54C																							
3.55	FEED	60																									
	PERM	15	20	5.4																							
				@ 18C																							
6.00	FEED	50																									
	PERM	25	33	10																							
				@ 55C																							
7.00	PERM	35	47	5.4																							
				@ 17C																							
8.15	PERM	35	47	5.8																							
				@ 23C																							
10.00	PERM	45	60	13.4																							
				@ 58C																							
11	FEED	5			9.9	43	16	6	10	13.1	17	66	10	16	11.7	20.2	49										
	PERM	55	73	3.5	9.8	37	8.0	5.0	3.0	3.4	13.6	16.0	4.0	12.4	10.7	16.8	35.1	14	50	17	70	74	20	76	60	17	28

COMMENTS:EVAPORATIVE LOSS 10L

AS TABLE 45

EXPERIMENT NO 9 : ELECTROLYSIS OF EFFLUENT SAMPLE A

ANOLYTE : 30 L FROM EXP 9 NF
CATHOLYTE : 15L NAOH
ABSORBTION COL : 30 L RAW SCOUR EFFLUENT

SAMPLE	TIME (h-min)	CURRENT DENSITY (A/sq.m)	FARADAY PASSED (F)	VOLTAGE (V)					TEMP. CELSIUS	VOLUME (l)	SAMPLE ANALYSIS													
				OVERALL	CELL	MEMBRANE	C-M	A-M			pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	OH- (g/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	Na+ (g/l)	Ca++ (mg/l)	Mg++ (mg/l)	COD (g/l)	TS (g/l)
ANOLYTE	0,00	60	0,0	4,5					25	30,0	8,8	23,2	6,0	2,0	4,0	0,0	3,4	12,3	11,4	7,8	10	1	0,6	
CATHOLYTE		600		8,2						15,0		40,3				75,2	1,5	0,0	1,1	99,2				
ABS.COL.		1200		12,3	4,9	0,51	0,7	3,2		30,0	13,1	63,8	4,0	0,3	3,7	4,1	2,6	0,0	1,9	8,4	45	7	8,3	22,0
					8,1	0,29	1,3	6,8																
	0,10	1200	0,1	15,2					27															
		1000		13,8		0,61																		
						0,35																		
ABS.COL.		1000	5,6	15,4					50		11,5													
		800		12,8		0,13																		
						0,21																		
ABS.COL.	3,22	800	6,1	15,4					54		10,9													
		600		11,8		0,10																		
						0,17																		
ANOLYTE	4,17	600	7,1	15,4		0,08			53	28,3	7,8		1,3	0,1	1,2	0,0	1,8	2,9	3,4	2,8				
						0,17																		
CATHOLYTE										16,2						73,9	1,5	0,0	1,1	103,3				
ABS.COL.										30,0	9,6		7,3	0,8	6,5	0,0	7,4	5,7	9,5					
		400		11,4		0,08																		
						0,18																		
ABS.COL.	5,25	400	7,9	15,3					51		9,3													
		300		12,5		0,25																		
						0,22																		
ANOLYTE	6,10									27,5	5,7	2,4	0,4	0,1	0,3	0,0	0,0	1,0	0,7	0,5	1	0	0,7	1,7
CATHOLYTE		300	8,3	15,4	6,0	0,34	0,9	4,7	45	16,3		41,1				72,7	1,5	0,0	1,1	102,2				
					8,8	0,29	1,0	7,5																
ABS.COL.										30,0	9,6	24,9	7,8	2,9	4,9	0,0	6,2	7,8	10,2					

A5 TABLE 46

EXPERIMENT NO 9 : ELECTROLYSIS OF EFFLUENT SAMPLE 6

ANOLYTE : 25 L FROM EXP 9 NF
CATHOLYTE : 15L NAOH
ABSORBTION COL : 30 L FROM EXP 9 CELL A + 25 L RAW SCOUR EFFLUENT

SAMPLE	TIME (h-min)	CURRENT DENSITY (A/sq.m)	FARADAY PASSED (F)	VOLTAGE (V) OVERALL	VOLTAGE (V) CELL	VOLTAGE (V) MEMBRANE	VOLTAGE (V) C-M	VOLTAGE (V) A-M	TEMP. CELSIUS	VOLUME (l)	SAMPLE ANALYSIS pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	OH- (g/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	Na+ (g/l)	Ca++ (mg/l)	Mg++ (mg/l)	COD (g/l)	TS (g/l)
ANOLYTE	0,00	60	0,0	4					18	25,0	9,4	19,6	6,5	3,5	3,0	0,0	4,2	6,5	7,8	5,9	18	1,2		
CATHOLYTE		600		8,4						15,0		31,6				53,9	1,5	0,0	1,1	72,5				
ABS.COL.		1200		14,2	5,6	0,42	1,1	3,9		55,0	12,6	33,6	6,8	2,0	4,8	0,8	7,9	0,0	5,7	7,8	32	4		
					8,0	0,29	1,5	6,0																
ABS.COL.	1,35	1200	3,4	15,3					38		12,1													
		1000		13,6		0,33																		
						0,11																		
ABS.COL.	3,06	1000	6,2	15,6					45		9,8													
		800		14,5		0,20																		
						0,2																		
	3,11	800	6,3	15,1																				
		600		13,2		0,20																		
						0,19																		
ANOLYTE	3,59	600	7,2	15,5					45	24,0	9,1		2,6	0,2	2,4	0,0	2,0	2,7	3,4	2,9				
CATHOLYTE										16,0						59,1	1,5	0,0	1,1	80,2				
ABS.COL.										55,0	9,2		8,3	5,5	2,8	0,0	4,6	10,9	11,2					
		400		14,4		0,13																		
						0,02																		
	4,05	400	7,2	15,1																				
		300		14,7		0,38																		
						0,30																		
ANOLYTE		300	7,4		6,4	0,37	0,9	5,1	49	23,7	5,6	2	0,9	0,1	0,8	0,0	0,0	0,5	0,4	0,3	2	0,4	1,0	
					9,3	0,28	1,1	8,2																
CATHOLYTE										16,0		32,1				57,4	1,5	0,0	1,1	81,3				
ABS.COL.										55,0	9,1	24,1	13,8	3,8	10,0	0,0	4,3	10,5	10,7					

AS TABLE 47

EXPERIMENT NO 10 : CARBONATION

ANOLYTE : 50 L AT 112G/L NAHCO3
CATHOLYTE : 15L NAOH
ABSORBTION COL : 25 L FROM EXP 8 CELL C + 35 L RAW SCOUR EFFLUENT INITIALLY, TOTAL = 120 L

SAMPLE	TIME (h-min)	CURRENT DENSITY (A/sq.m)	FARADAY PASSED (F)	VOLTAGE (V) OVERALL	CELL	MEMBRANE	C-M	A-M	TEMP. CELSIUS	VOLUME (l)	SAMPLE ANALYSIS pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	OH- (g/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	Na+ (g/l)	Ca++ (mg/l)	Mg++ (mg/l)	COD (g/l)	TS (g/l)
ANOLYTE	0,00	60	0,0	4,7					16	50,0	8,1	37,3		7,0		0,0	4,9	27,7	23,6	28,2				
CATHOLYTE		1200		10,6						15,0		19,5				36,9	2,9	0.0	2,1	49,6				
ABS.COL.		2500		17,3	6,9	0,68	1,4	4,6		60,0	12,6	36,7	5,1	1,0	4,2	1,3	3,7	0,0	2,7	8,4	23	2,1		
					9,5	0,48	2,0	6,7																
ANOLYTE	2,58	2500	13,9	14,3		0,40			49	46,9	9,3			4,7		0,0	7,4	17,4	18,0	12,7				
						0,20																		
CATHOLYTE										17,2						40,1	1,7	0,0	1,2	59,9				
ABS.COL.										60,0	8,9		7,9	4,5	3,4	0,0	2,9	15,0	12,9					
ADDED FURTHER 60 L SCOUR EFFLUENT TO ABSORPTION COLUMN. TRANSFERRED INITIAL 60 L TO CROSS-FLOW MICROFILTER.																								
ABS.COL.	5,30		25,1	15,4					59		7,5													
		2000		12,6																				
ANOLYTE	7,55	2000	33,6	13	4,6	0,13	1,1	3,2	54	42,6	7,6	29,2		3,4		0,0	5,0	15,3	14,7	9,3				
					8,5	0,25	1,5	7,2																
CATHOLYTE										18,9		29,9				54,0	1,5	0,0	1,1	81,9				
ABS.COL.										60 + 60	8,9	26	7,4	4,8	2,6	0,0	3,0	16,0	13,7					

AS TABLE 48

EXPERIMENT 10: MICROFILTRATION

FEED: 120L FROM EXP 10 CARBONATION

TIME (h-min)	SAMPLE	VOL (l)	PERM. RECOVERY (%)	FLUX (l/m2/h)	SAMPLE ANALYSIS													POINT REJECTION (%)									
					pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	COD (g/l)	Na (g/l)	Ca (mg/l)	Mg (mg/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	TS (g/l)	COND	TC	IC	OC	COD	Na	Ca	Mg	TOT. CO2	TS
0.00	FEED	120			8.5	25	11.0	4.5	6.5	1.2	8.5	50.0	3.5	1.8	16.7	13.4	21.9										
	PERM	0	0	1.9 @ 29C	8.8	26	7.6	4.3	3.3	4.0	8.4	23.0	2.1	2.8	14.9	12.8	22.9	0	31	4	49	0	1	54	40	5	0
*AT THIS STAGE SOME LIQUOR WAS LOST DUE TO A PUMP LEAKAGE																											
40.30				1.4 @ 40C																							
43.10	FEED	10																									
	PERM	60	50		9.2	28	8.5	5.6	2.9	5.9	9.8	3.8	4.4	14.6	13.8	26.0											

COMMENTS: EVAPORATIVE LOSS AND LOSS THROUGH GLAND OF PUMP SOL

AS TABLE 49

EXPERIMENT 10: NANOFILTRATION

FEED: 60L FROM EXP 10 CROSS-FLOW MICROFILTRATION

TIME (h-min)	SAMPLE	VOL (l)	PERM. RECOVERY (%)	FLUX (l/m2/h)	SAMPLE ANALYSIS													POINT REJECTION (%)									
					pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	COD (g/l)	Na (g/l)	Ca (mg/l)	Mg (mg/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	TS (g/l)	COND	TC	IC	OC	COD	Na	Ca	Mg	TOT. CO2	TS
0.00	FEED	60																									
	PERM	0	0	6.1 @ 20C	8.9	19	3.8	2.1	1.8	0.5	6.3	10.0	1.0	2.2	10.1	8.9	14.6										
2.22	PERM	10	17	7.5 @ 38C																							
4.43	PERM	20	33	7.4 @ 45C																							
7.05	PERM	30	50	6.9 @ 47C																							
9.50	PERM	40	67	6.6 @ 49C																							
	PERM	40	67	5.2 @ 19C																							
13.00	FEED	5			9.5	43	26.5	6.4	20.1	55.6	20.4	249.0	36.0	12.6	21.0	24.4	78.9										
	PERM	55	92		9.5	45	7.8	7.3	0.5	0.8	18.2	51.0	5.5	11.8	19.3	22.6	47.5	0	71	0	98	99	11	80	85	7	40

COMMENTS:

COMPANY:

A5 TABLE 50

EXPERIMENT NO 10 : ELECTROLYSIS OF EFFLUENT SAMPLE A

ANOLYTE : 25 L FROM EXP 10 NF
CATHOLYTE : 15L NAOH
ABSORBTION COL : 25 L RAW SCOUR EFFLUENT

SAMPLE	TIME (h-min)	CURRENT DENSITY (A/sq.m)	FARADAY PASSED (F)	VOLTAGE (V)					TEMP. CELSIUS	VOLUME (l)	SAMPLE ANALYSIS													
				OVERALL	CELL	MEMBRANE	C-M	A-M			pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	OH- (g/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	Na+ (g/l)	Ca++ (mg/l)	Mg++ (mg/l)	COD (g/l)	TS (g/l)
ANOLYTE	0,00	60	0,0	4,5					26	25,0	9,5	21,1	4,4	2,2	2,2	0,0	5,4	9,6	10,9	7,6	15	1		
CATHOLYTE		600		7,7						15,0		38,7				66,9	2,0	0,0	1,4	96,2				
ABS.COL.		1200		11,7	4,9	0,26	1,1	3,4		25,0	12,8	51,7	4,4	0,5	4,0	2,8	3,8	0,0	2,7	7,1	167	8,2	9,9	13,4
					7,5	0,29	1,6	6,7																
	2,00	1200	4,4	15					50															
		1000		12,4	4,3	0,25	0,3	3,2																
					7,4	0,17	1,3	6,3																
	2,45	1000	5,9	15					54															
ABS.COL.		800		11,6	4,2	0,15	1,0	3,2			9,8													
					7,1	0,15	1,2	6,2																
ABS.COL.	3,30	800	7,0	15					55		9,3													
		600		11,8	4,4	0,10	1,0	3,4																
					7,3	0,16	1,1	6,0																
ANOLYTE	4,25	600	8,0	15,1					57	22,5	8,6		2,3	0,6	1,7	0,0	1,0	3,5	3,2	2,3				
CATHOLYTE										16,4						73,0	3,0	0,0	2,2	102,0				
ABS.COL.										25,0	9,1		8,9	2,9	6,0	0,0	5,0	8,4	9,7					
		400		11,1	4,8	0,07	1,0	3,8																
					6,4	0,19	1,0	5,1																
	5,12	400	8,6	15,1																				
		300		12,6	5,8	0,06	1,0	4,9	53															
					6,9	0,19	1,0	5,8																
ANOLYTE	5,45	300	8,9	15,2					54	21,7	2,3	1,4	1,0	0,0	1,0	0,0	0,0	0,0	0,0	0,2	5	1	1,2	
CATHOLYTE										16,7		41				74,0	1,5	0,0	1,1	105,8				
ABS.COL.										25,0	8,6	22,5	8,1	2,2	5,9	0,0	2,0	14,6	12,0					

A5 TABLE 51

EXPERIMENT NO 10 : ELECTROLYSIS OF EFFLUENT SAMPLE B

ANOLYTE : 25 L FROM EXP 10 NF
CATHOLYTE : 15L NAOH
ABSORBTION COL : 25 L FROM EXP 10 CELL A + 25 L RAW SCOUR EFFLUENT

SAMPLE	TIME (h-min)	CURRENT DENSITY (A/sq.m)	FARADAY PASSED (F)	VOLTAGE (V)					TEMP. CELSIUS	VOLUME (l)	SAMPLE ANALYSIS													
				OVERALL	CELL	MEMBRANE	C-M	A-M			pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	OH- (g/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	Na+ (g/l)	Ca++ (mg/l)	Mg++ (mg/l)	COD (g/l)	TS (g/l)
ANOLYTE	0,00	40	0,0	4,2					21	25,0	9,4	24,8	4,8	3,3	1,5	0,0	5,4	9.6	10,9	7,7	19	1,4		
CATHOLYTE		600		8,3						15,0		32,6				55,7	1,5	0,0	1,1	81,8				
ABS.COL.		1200		13,2	5,5	0,40	1,2	3,8		50,0	9,9	23	6,8	2,8	3,9	0,0	6,6	5,1	8,5	7,2	52	5,7	8,6	
					9,2	0,24	1,8	7,6																
	0,03	1200	0,1	15,3					23															
		1000		13,5																				
ABS.COL.	2,50	1000	5,2	15	4,9	0,17	1,0	3,7	47		9,2													
					9,9	0,18	1,3	8,0																
		800		12																				
	4,05	800	7,1	16																				
		600		14,8		0,11																		
						0,16																		
ANOLYTE	4,10	600	7,2						50	22,5	7,2		1,5	0,5	1,0	0,0	1,6	1,5	2,3	1,4				
CATHOLYTE										16,2						57,8	1,5	0,0	1,1	84,5				
ABS.COL.										50,0	9,1		6,0	3,2	2,8	0,0	3,6	11,7	11,1					
		400		11,5	4,8	0,09	1,0	3,7																
					6,4	0,24	1,0	5,0																
	3,50	400	7,7	15,3																				
		300		13,1	5,9	0,28	1,0	4,7																
					7,2	0,32	1,0	5,7																
ANOLYTE	5,20	300	8,0	13,4					47	21,5	4,5	1,8	0,4	0,0	0,4	0,0	0,0	0,4	0,3	0,3	4	0,2	1,3	
CATHOLYTE										16,3		34,1				58,2	1,5	0,0	1,1	84,7				
ABS.COL.										50,0	8,6	22,7	7,1	0,1	7,0	0,0	1,0	16,2	12,4	7,0				

A5 TABLE 52

EXPERIMENT NO 11 : CARBONATION

ANOLYTE : 50 L AT 112G/L NAHCO3
CATHOLYTE : 15L NAOH
ABSORBTION COL : 55 L FROM EXP 9 CELL 8 + RAW SCOUR EFFLUENT INITIALLY, TOTAL = 160 L

SAMPLE	TIME (h-min)	CURRENT DENSITY (A/sq.m)	FARADAY PASSED (F)	VOLTAGE (V)					TEMP. CELSIUS	VOLUME (l)	SAMPLE ANALYSIS													
				OVERALL	CELL	MEMBRANE	C-M	A-M			pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	OH- (g/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	Na+ (g/l)	Ca++ (mg/l)	Mg++ (mg/l)	COD (g/l)	TS (g/l)
ANOLYTE	0,00	60	0,0	4,5					20	50,0	8,3	51		12,0		0,0	6,5	44,7	37,0	30,0				
CATHOLYTE		1000		9,1						15,0		24				41,7	1,5	0,0	1,1	59,5				
ABS.COL.		2500		14,7	6,3	0,31	1,5	4,3		60,0	9,6	24,4	7,3	2,3	5,0	0,0	7,2	5,5	9,2	8,4	37	3		
					7,8	0,27	1,7	5,5																
ANOLYTE	3,10	2500	14,6	12,9					47	48,9	8,1	45,4		9,3		0,0	8,3	28,8	26,9	17,6				
CATHOLYTE										16,9						48,5	1,5	0,0	1,1	66,6				
ABS.COL.										60,0	7,7	24,3	8,0	4,5	3,5	0,0	0,0	19,9	14,4					
ADDED FURTHER 60 L SCOUR EFFLUENT TO ABSORPTION COLUMN																								
ABS.COL.		2000	14,6	10,6	4,2	0,22	1,1	2,8	49	120,0	13,0													
					5,9	0,35	1,2	4,3																
ANOLYTE	6,54	2000	28,5	11					50	44,4	8,3	41,8		8,0		0,0	10,7	18,8	21,4	15,8				
CATHOLYTE										19,8						58,2	1,5	0,0	1,1	81,1				
ABS.COL.										60 + 60	8,6	24,4	8,9	4,4	4,5	0,0	1,9	16,1	13,0					
ADDED FURTHER 40 L SCOUR EFFLUENT TO ABSORPTION COLUMN.																								
ANOLYTE	11,09	2000	44,7	12,8	4,7	0,10	1,1	3,5	48	40,8	8,1	22		3,2		0,0	3,8	10,6	10,4	6,9				
					7,5	0,22	1,4	5,9																
CATHOLYTE										21,2		37,6				65,9	1,5	0,0	1,1	94,8				
ABS.COL.										120 + 40	8,3	24	9,4	4,5	4,9	0,0	2,6	15,4	13,0					

AS TABLE 53

EXPERIMENT 11: MICROFILTRATION

FEED: 120L FROM EXP 11 CARBONATION

TIME	SAMPLE	VOL	PERM. RECOVERY	FLUX	SAMPLE ANALYSIS													POINT REJECTION (%)									
(h-min)		(l)	(%)	(l/m2/h)	pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	COD (g/l)	Na (g/l)	Ca (mg/l)	Mg (mg/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	TS (g/l)	COND	TC	IC	OC	COD	Na	Ca	Mg	TOT. CO2	TS
0.00	FEED	120			8.7	24	7.9	4.3	3.6	8.3	8.2	45.0	4.6	1.9	16.1	13.0	22.1										
	PERM	0		2.8 @ 400KP	8.6	24	7.3	4.5	2.8	5.9	8.2	17.0	4.3	2.2	16.0	13.2	20.8	0	8	0	22	29	0	62	7	0	6
14.04	PERM	80																									
25.34	AT THIS STAGE 40L ABSORPTION COLUMN EFFLUENT FROM EXP 11 CARBONATION WAS ADDED TO THE FEED																										
46.34	FEED	10			8.8	25	8.4	4.7	3.7	27.3	9.1	46.0	7.5	2.3	17.3	14.2	52.4										
	PERM	130	81	2.7 @ 300KP @ 39C	9.3	21	5.9	2.8	3.1	4.2	6.8	28.0	5.5	4.2	8.3	9.1	18.3	18	30	40	16	43	25	39	27	36	31

COMMENTS: EVAPORATIVE LOSS 20L

AS TABLE 54

EXPERIMENT 11: NANOFILTRATION

FEED: 50L FROM EXP 11 CROSS-FLOW MICROFILTRATION

TIME (h-min)	SAMPLE	VOL (l)	PERM. RECOVERY (%)	FLUX (l/m2/h)	SAMPLE ANALYSIS pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	COD (g/l)	Na (g/l)	Ca (mg/l)	Mg (mg/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	TS (g/l)
0.00	FEED	50			8.4	25	7.6	4.6	3.0	5.3	8.8	23.0	5.6	2.0	16.5	13.4	20.2
	PERM	0	0	6.1	8.6	17	4.0	2.5	1.6	0.0	5.5		2.5	2.8	8.1	7.9	13.1
				@ 21C													
2.45	PERM	10	20	8.5													
				@ 40C													
5.00	PERM	20	40	8.8													
				@ 52C													
25.00	PERM	40	80														
AT THIS STAGE A FURTHER 80L OF MICROFILTRATE WAS ADDED TO THE FEED																	
25.00	PERM	50	38	6.6													
				@ 16C													
30.15	FEED	10			8.9	33	21.1	4.9	16.2	42.7	14.5	250.0	34.0	4.0	23.7	20.0	57.1
	PERM	110	85	5.1	9.0	34	13.9	5.6	8.3	8.5	11.5	34.0	9.4	4.9	14.6	14.1	25.6

TIME (h-min)	SAMPLE	POINT REJECTION (%) COND	TC	IC	OC	COD	Na	Ca	Mg	TOT. CO2	TS
0.00	FEED										
	PERM	29	47	46	47	91	38		55	41	35
2.45	PERM										
5.00	PERM										
25.00	PERM										
AT THIS STAGE A FURTHER 80L OF MICROFILTRATE WAS ADDED TO THE FEED											
25.00	PERM										
30.15	FEED										
	PERM	0	34	0	49	80	21	86	72	30	56

COMMENTS: EVAPORATIVE LOSS 10L

A5 TABLE 55

EXPERIMENT NO 11 : ELECTROLYSIS OF EFFLUENT SAMPLE A

ANOLYTE : 35 L FROM EXP 11 NF
CATHOLYTE : 15L NaOH
ABSORBTION COL : 35 L RAW SCOUR EFFLUENT

SAMPLE	TIME	CURRENT DENSITY	FARADAY PASSED	VOLTAGE (V)					TEMP. CELSIUS	VOLUME	SAMPLE ANALYSIS													
	(h-min)	(A/sq.m)	(F)	OVERALL	CELL	MEMBRANE	C-M	A-M		(l)	pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	OH- (g/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	Na+ (g/l)	Ca++ (mg/l)	Mg++ (mg/l)	COD (g/l)	TS (g/l)
ANOLYTE	0,00	60	0,0	4,7					16	35,0	8,8	23				0,0	3,4	11,5	10,8	7,2	21	3		
CATHOLYTE		600		8,7						15,0		33,6				59,5	1,5	0,0	1,1	84,9				
ABS.COL.		1200		16,3						35,0	12,6	43,3	3,9	0,7	3,2	2,4	4,1	0,0	3,0	7,2	32	5	7,2	21,7
		1000	0,1	14,5	5,4	0,46	1,4	3,5																
					8,9	0,33	1,6	6,5																
ABS.COL.	1,48	1000	3,1	15,1							12,6													
		800		12,7		0,33			39															
						0,35																		
ABS.COL.	3,27	800	5,6	15							9,8													
		600		11,5		0,20			42															
						0,41																		
ANOLYTE	5,30	600	7,9	15	4,6	0,22	1,0	3,7	47	31,0	7,0		5,0	1,2	3,8	0,0	3,4	1,8	3,8	2,9				
					9,0	0,36	1,2	7,4																
CATHOLYTE										16,1						70,1	1,5	0,0	1,1	97,7				
ABS.COL.										35,0	9,2		76,4	3,7	72,7	0,0	4,1	9,3	9,7					
		400		10,7	4,2	0,23	1,0	3,0																
					6,4	0,36	1,1	5,1																
ABS.COL.	7,30	400	9,4	15					48		8,1													
		300		11,9		0,28																		
						0,37																		
ANOLYTE	8,40	300	10,1	15,4	6,4	0,31	1,0	5,0	47	29,0	3,4	1,6	0,4	0,0	0,4	0,0	0,0	0,0	0,0	0,3	4	1,2	0,9	
					9,0	0,39	1,0	7,5																
CATHOLYTE										16,5		39,1				69,7	1,5	0,0	1,1	97,4				
ABS.COL.										35,0	8,8	21	8,4	4,1	4,3	0,0	2,4	11,9	10,3					

A5 TABLE 56

EXPERIMENT NO 11 : ELECTROLYSIS OF EFFLUENT SAMPLE 8

ANOLYTE : 35 L FROM EXP 11 NF
CATHOLYTE : 15L NAOH
ABSORBTION COL : 35 L RAW SCOUR EFFLUENT

SAMPLE	TIME (h-min)	CURRENT DENSITY (A/sq.m)	FARADAY PASSED (F)	VOLTAGE (V)					TEMP. CELSIUS	VOLUME (l)	SAMPLE ANALYSIS													
				OVERALL	CELL	MEMBRANE	C-M	A-M			pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	OH- (g/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	Na+ (g/l)	Ca++ (mg/l)	Mg++ (mg/l)	COD (g/l)	TS (g/l)
ANOLYTE	0	60	0,0	5					19	35,0	9,0	22,8				0,0	3,4	11,5	10,8	7,2	21	3,3		
CATHOLYTE		600		8,5						15,0		36				63,3	1,5	0,0	1,1	87,7				
ABS.COL.		1200		18,7						35,0	12,6	30,8	1,6	0,1	1,5	1,7	1,3	0,0	0,9	3,7	21	3,4		
		1000		15,9																				
		800	0,2	13,4	4,7	0,32	1,1	3,1																
					8,4	0,28	1,3	6,2																
ANOLYTE	5,35	800	8,3	13,5		0,06			50	32,2	7,7	14,4	4,9	0,0	4,9	0,0	2,9	7,0	7,2	4,2				
						0,09																		
CATHOLYTE										16,1						67,2	1,5	0,0	1,1	91,3				
ABS.COL.										35,0	8,4	13,6	6,0	2,0	4,0	0,0	0,6	8,8	6,8					
ABS.COL.	6,15	800	9,4	15					50		7,2													
		600		11,4	4,3	0,08	1,1	3,2																
					6,8	0,09	1,1	5,6																
ANOLYTE	7,30	600	10,8	15,3	5,3	0,08	1,1	4,2	53	31,3	6,4	5,4	0,4	0,4	0,0	0,0	0,5	2,1	1,9	1,4	2	1	1,8	
					10,1	0,09	1,2	8,8																
CATHOLYTE										16,2		36,5				69,7	1,5	0,0	1,1	92,5				
ABS.COL.										35,0	8,3	13,6	5,6	2,0	3,6	0,0	0,7	9,4	7,3					

AS TABLE 57

EXPERIMENT NO 11 : ELECTROLYSIS OF EFFLUENT SAMPLE C

ANOLYTE : 35 L FROM EXP 11 NF
CATHOLYTE : 15L NAOH
ABSORBTION COL. : 35 L SCOUR EFFLUENT

SAMPLE	TIME	CURRENT DENSITY	FARADAY PASSED	VOLTAGE (V)					TEMP. CELSIUS	VOLUME	SAMPLE ANALYSIS													
	(h-min)	(A/sq.m)	(F)	OVERALL	CELL	MEMBRANE	C-M	A-M		(l)	pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	OH- (g/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	Na+ (g/l)	Ca++ (mg/l)	Mg++ (mg/l)	COD (g/l)	TS (g/l)
ANOLYTE	0,00	60	0,0	4,8					19	35,0	9,0	22,8	5,9	5,2	0,7	0,0	4,4	9,4	10,0	7,4	19	3,6		
CATHOLYTE		600		8,7						15,0		25				43,8	1,5	0,0	1,1	63,8				
ABS.COL.		1200		18,5						35,0	12,6	56,2	4,3	0,2	4,1	3,7	1,7	0,0	1,8	7,2				
		1000		16																				
		800		13,6	4,8	0,50	1,2	3,0																
					9,0	0,23	1,6	7,2																
ABS.COL.	4,45	800	6,9	15,4					51		9,7													
		600		12,2	4,3	0,31	0,9	3,2																
					7,6	0,11	1,2	6,6																
ANOLYTE	6,00	600	8,2	15,3					53	31,1	6,3		1,5	0,3	1,2	0,0	0,4	2,3	1,9	1,1				
CATHOLYTE										15,8						46,3	1,5	0,0	1,1	75,4				
ABS.COL										35,0	9,2		6,3	3,1	3,7	0,0	4,6	8,5	9,5					
		400		11,7	4,6	0,19	1,0	3,3																
					7,0	0,15	1,0	5,9																
	7,15	400	9,1	15,4					52															
ABS.COL.		300		13,2	6,2	0,46	1,0	4,7			8,5													
					7,6	0,19	1,0	6,5																
ANOLYTE	8,45	300	9,4	15,5	8,4	0,26	1,1	7,5	54	29,7	2,0	1,8	0,8	0,0	0,8	0,0	0,0	0,0	0,0	0,1	6	0,8	1,8	
					8,8	0,13	1,0	7,7																
CATHOLYTE										16,0		27,3				44,2	1,5	0,0	1,1	75,1				
ABS.COL.										35,0	8,9	21,1	8,0	3,1	4,9	0,0	3,1	10,7	10,0					

A5 TABLE 5B

EXPERIMENT 12: MICROFILTRATION

FEED: 50L FROM EXP 10B + 35L FROM EXP 11A , TOTAL FEED : 120L

TIME	SAMPLE	VOL	PERM. RECOVERY	FLUX	SAMPLE ANALYSIS													POINT REJECTION (%)									
(h-min)		(l)	(%)	(l/m2/h)	pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	COD (g/l)	Na (g/l)	Ca (mg/l)	Mg (mg/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	TS (g/l)	COND	TC	IC	OC	COD	Na	Ca	Mg	TOT. CO2	TS
0.00	FEED	85			8.3	21	4.8	3.1	1.7	5.9	6.9	49.0	7.0	3.7	9.5	9.6	21.9										
	PERM	0	0	2.8 @ 200KP @ 30C	8.7	22	4.3	2.8	1.5	2.2	7.9	17.0	5.0	5.0	7.6	9.1	18.2	0	10	10	12	63	0	65	29	5	17
5.55	PERM	5	56																								
AT THIS STAGE 35L WAS ADDED FROM EXP 11B																											
19.55	PERM	20	17																								
28.25	PERM	55	46	2.3 @ 200KP @ 38C																							
43.45	FEED	10																									
	PERM	85	71																								

COMMENTS:EVAPORATIVE LOSS 25L

AS TABLE 59

EXPERIMENT 12: NANOFILTRATION

FEED: 30L FROM EXP 12 MICROFILTRATION, TOTAL FEED 80L

TIME (h-min)	SAMPLE	VOL (l)	PERM. RECOVERY (%)	FLUX (l/m2/h)	SAMPLE ANALYSIS pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	COD (g/l)	Na (g/l)	Ca (mg/l)	Mg (mg/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	TS (g/l)	POINT REJECTION (%) COND	TC	IC	OC	COD	Na	Ca	Mg	TOT. CO2	TS
0.00	FEED	30			9.2	20	4.0	3.0	1.0	1.9	6.7	20.0	4.2	4.8	11.1	11.5	16.7										
	PERM	0	0	5	8.9	12	1.9	1.5	0.4	0.7	3.4		2.8	1.6	5.5	5.1	8.7	42	53	50	60	63	49		33	56	48
				@ 1,6MP																							
				@ 18C																							
2.15	PERM	5	17	6.6																							
				@ 1,6MP																							
				@ 36C																							
AT THIS STAGE THE EXP WAS STOPPED AND THEN RESTARTED																											
5.45	PERM	20	67	8.3																							
				@ 1,6MP																							
8.00	FEED	0		@ 48C																							
	PERM	30	100	5.4																							
				@ 1,4MP																							
				@ 55C																							
AT THIS STAGE THE EXP WAS RESTARTED WITH A NEW FEED OF 50L FROM EXP 12 CROSS-FLOW MICROFILTRATION																											
0.00	FEED	50																									
	PERM	0	0	5.8																							
				@ 2MP																							
				@ 20C																							
9.10	PERM	35	70																								
10.50	PERM	40	80	6.1																							
				@ 1,6MP																							
				@ 46C																							
11.30	FEED	4			9.7	41	17.8	7.5	10.3	16.6	17.6	107	28	12.4	15	19.9	47.6										
	PERM	46	92		9.5	33	11.8	5.3	6.5	3.5	11.2	12	6	8.6	11.6	14.7	28.6	20	34	29	37	79	36	89	79	26	40

COMMENTS:

COMPANY:

ANOLYTE : 35 L EXP 12 NF
CATHOLYTE : 20L NaOH
ABSORBTION COL : 45 L RAW SCOUR EFFLUENT INITIALLY, TOTAL = 90 L

SAMPLE	TIME (h-min)	CURRENT DENSITY (A/sq.m)	FARADAY PASSED (F)	VOLTAGE (V) OVERALL	CELL	MEMBRANE	C-M	A-M	TEMP. CELSIUS	VOLUME (l)	SAMPLE ANALYSIS pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	OH- (g/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	Na+ (g/l)	Ca++ (mg/l)	Mg++ (mg/l)	COD (g/l)	TS (g/l)
ANOLYTE	0,00	160	0,0	5,7						35,0	9,1	21,6	5,8	4,8	0,9	0,0	4,2	8,4	9,1	7,0	13,00	2,30	0,7	
CATHOLYTE		400		7,4						20,0		25,8				42,5	3,0	0,0	2,2	65,0				
ABS.COL.		800		10,2						45,0	12,5	29,6	1,8	0,2	1,6	1,8	1,1	0,9	0,8	3,9	17,00	4,40	4,3	
		1200		14,0																				
											FLOW (CM ON ROTAMETER) ANOLYTE	CATHOLYTE		FLOW (L/MIN) ANOLYTE	CATHOLYTE									
		600		9,0	4,1	0,23	1,1	2,7	22		16	18		13,5	15,3									
					4,9	0,19	1,3	3,7																
	0,05	600		10,0																				
	0,35	600	0,7	9,8	4,1	0,46	0,9	2,7	35		16	18		13,5	15,3									
					5,3	0,17	1,2	4,1																
	0,45	600		9,3	4,1	0,39	1,0	2,3			18	18		15,3	15,3									
					5,0	0,18	1,2	3,6																
	0,45			8,9	4,1	0,40	1,0	2,7			20	18		17,1	15,3									
					4,6	0,19	1,2	3,2																
				8,5	4,1	0,40	1,0	2,7			22	18		19,0	15,3									
					4,2	0,19	1,1	2,8																
				10,3	4,2	0,43	0,9	2,7			14	18		11,8	15,3									
					6,0	0,18	1,3	4,6																
				10,8	4,1	0,42	0,7	2,8			12	18		10,2	15,3									
					6,4	0,13	1,3	5,2																
		1000	1,1	15,3	4,8	0,62		3,4			12	18		10,2	15,3									
					10,3	0,15		8,5																
ABS.COL.				13,6	4,9			3,4			15	18		12,7	15,3									
					8,3			6,6																
				12,0	4,8			3,4			19	18		16,2	15,3									
ANOLYTE					6,8			5,2																
CATHOLYTE				10,2	4,8			3,7			22	18		19,0	15,3									
ABS.COL.					5,0			3,3																
				15,8	4,9			3,4			10	18		8,5	15,3									
					10,35			8,20																
				16,9	4,90			3,50			5	18		4,6	15,3									
					11,10			9,70																
				13,0	4,96						2	18		2,4	15,3									
					12,20																			
				15,9	4,90			3,49			2	2		2,4	2,4									
					10,40			9,29																
				16,9	4,97			3,50			1	1		1,3	1,3									
					11,33			9,50																
				17,0	4,96						1	10		1,3	8,5									
					11,60																			
				14,8	4,83						1	10		1,3	8,5									
					9,78																			
	2,00	1200	3,10	13,0																				
	2,20	1400		15,8																				
	3,05	1400	5,50	12,0	5,20				46															
					5,70																			
ABS.COL.	3,30	1400	6,80	15,3							8,3													

A5 TABLE 60 (cont.)

SAMPLE	TIME (h-min)	CURRENT DENSITY (A/sq.m)	FARADAY PASSED (F)	VOLTAGE (V) OVERALL	CELL	MEMBRANE	C-M	A-M	TEMP. CELSIUS	VOLUME (l)	SAMPLE ANALYSIS pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	OH- (g/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	Na+ (g/l)	Ca++ (mg/l)	Mg++ (mg/l)	COD (g/l)	TS (g/l)
ADDED A FURTHER 10 L SCOUR EFFLUENT TO ABS.COL. TOTAL VOLUME = 55 L.																								
		1200		13,7																				
ANOLYTE PUMP SWITCHED OFF AT 3.8 F. WAS RESTARTED.																								
	4,35	1200		20,9																				
		600		10,6	3,90																			
					6,50																			
	5,00	800	9,10	14,6																				
ADDED FURTHER 15 L SCOUR EFFLUENT TO ABS.COL. TOTAL VOLUME = 70 L.																								
ANOLYTE	5,10	800	9,30	11,0	4,65				48	32,5	7,3		2,50	1,1	1,4	0,0	1,1	3,9	3,6	2,7			0,50	
CATHOLYTE					9,10					21,7						44,2	3,0	0,0	2,2	68,6				
ABS.COL.										70,0	9,1		4,30	0,6	3,6	0,0	2,0	5,1	5,1				3,60	
	5,45	300	10,30	16,1																				
ABS.COL.		600		12,0							8.8													
	6,10	600	10,70	13,0																				
ADDED FURTHER 20 L SCOUR EFFLUENT TO ABS COL AFTER REMOVING 50 L OF CARBONATED EFFLUENT																								
ANOLYTE	6,50	560	11,50	15,5	5,39				50	31,2	7,3	3,90	0,80	0,3	0,5	0,00	0,40	1,00	1,00	1,10	2,80	0,60	0,50	
					10,17																			
CATHOLYTE										21,9		27,60				45,90	3,00	0,00	2,20	70,60				
ABS.COL.										50 + 40	11,9	15,20	2,60	0,7	1,9	0,40	3,30	0,00	2,70				4,90	

A5 TABLE 61

EXPERIMENT NO 61 : ELECTROLYSIS OF EFFLUENT SAMPLE 8

ANOLYTE : 40 L FROM EXP 12 NF
CATHOLYTE : 15L NAOH
ABSORBTION COL : 20 L RAW SCOUR EFFLUENT + 20 L PARTLY CARBONATED EFFLUENT FROM EXP 12 CELL A

SAMPLE	TIME (h-min)	CURRENT DENSITY (A/sq.m)	FARADAY PASSED (F)	VOLTAGE (V) OVERALL	CELL	MEMBRANE	C-M	A-M	TEMP. CELSIUS	VOLUME (l)	SAMPLE ANALYSIS pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	OH- (g/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	Na+ (g/l)	Ca++ (mg/l)	Mg++ (mg/l)	COD (g/l)	TS (g/l)
ANOLYTE	0,00	60		4,5					19	40,0	9,5	19,9	3,4	2,9	0,5	0,0	4,8	5,5	8,8	6,3	9,3	1,2		
CATHOLYTE		800		10						15,0		28,4				52,7	3,0	0,0	2,2	65,1				
ABS.COL.		1200		19						40,0	12,8	30,3	2,5	0,3	2,2	1,8	2,0	0,0	1,4	5,0	25,4	2,8		
		1000		15,2																				
		800	0,1	12,6	4,3	0,98	0,8	3,2																
CATHOLYTE					8,8	0,25	1,4	6,4																
ABS.COL.																								
ANOLYTE PUMP STOPPED FOR UNKNOWN REASON AT 2.00 AND 4.00H AFTER BEGINNING OF EXPERIMENT.																								
ANOLYTE	5,55	800	6,9	15					38	39,1	7,2	10,4	1,7	0,8	0,9	0,0	1,9	2,9	3,5	3,2				
CATHOLYTE										15,7						47,6	3,0	0,0	2,2	62,3				
ABS.COL.										40,0	9,3	15	2,6	1,5	1,1	0,0	3,0	4,9	5,8					
		600		11,7	4,4	0,39	0,2	3,1																
					7,3	0,26	1,2	6,2																
ANOLYTE	7,55	600	9,1	15	5,0	0,40	1,0	3,5		38,5	6,9	6,7				0,0	0,7	2,2	2,1	1,9	4	0,8		
					8,9	0,33	1,2	7,3																
CATHOLYTE										15,8		24,5				44,2	3,0	0,0	2,2	64,9				
ABS.COL.										40,0	7,7	14,8	4,2	1,9	2,3	0,0	0,0	10,4	7,5					
ANOLYTE PUMP STOPPED PROBABLY DUE TO OVERHEATING.																								

AS TABLE 62

EXPERIMENT NO 13 : CARBONATION

ANOLYTE : 50 L AT 60G/L NAHCO3 AND 10G/L NA2CO3
CATHOLYTE : 15L NAOH
ABSORBTION COL : 50 L SCOUR EFFLUENT

SAMPLE	TIME (h-min)	CURRENT DENSITY (A/sq.m)	FARADAY PASSED (F)	VOLTAGE (V) OVERALL	CELL	MEMBRANE	C-M	A-M	TEMP. CELSIUS	VOLUME (l)	SAMPLE ANALYSIS pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	OH- (g/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	Na+ (g/l)	Ca++ (mg/l)	Mg++ (mg/l)	COD (g/l)	TS (g/l)
ANOLYTE	0,00	40	0,0	4,3					18	50,0	9,0	41		6,8		0,0	15,8	48,0	46,4	30,8				
CATHOLYTE		800		8,4						15,0		25				40,0	3,0	0,0	2,2	60,2				
ABS.COL.		1500		12,8						50,0	12,8	50	2,5	0,1	2,4	2,8	2,3	0,0	1,7	5,9	23	4	6,2	
		2000		15,3																				
		2500		18,4	6,4	0,71	1,5	4,0																
					10,4	0,4	1,9	7,0																
ANOLYTE	3,20	2500	15,8	15,9					53	48,6	8,2					0,0	7,8	20,1	20,3	14,1				
CATHOLYTE										17,7						48,5	3,0	0,0	2,2	77,5				
ABS.COL.										50,0	8,7		5,0	3,4	1,5	0,0	2,9	8,8	8,5					
		2000		12,3	4,2	0,34	1,0	2,8	53															
					7,3	0,19	1,5	5,6																
ANOLYTE	3,50	2000	17,4	12	4,2	0,32	1,1	2,8		48,1														
					7,3	0,18	1,6	5,5																
CATHOLYTE										17,9														
ABS.COL.										50,0														
STOPPED EXP TO CHECK ANOLYTE PUMP. CONTINUED FOLLOWING DAY AFTER CHANGING ABS. COL. LIQUOR																								
ANOLYTE	3,50	1500	17,5	11,8	5,3	0,30	1,5	3,3	22	48,4	8,0	37				0,0	4,1	27,1	22,5	14,3				
					6,5	0,31	1,7	4,3																
										17,9		31				54,4	3,0	0,0	2,2	79,2				
										50 + 50	8,0	18	5,9	3,1	2,8	0,0	1,4	11,6	9,4					
	6,40	1000																						
ANOLYTE	10,55	1000	32,6	8,3	3,7	0,27	1,0	2,4	48	42,3	8,0	34	5,8			0,0	5,2	21,0	18,9	12,7				
					4,4	0,20	1,3	2,9																
CATHOLYTE		0		3,8						17,9		30	0,8			52,7	3,0	0,0	2,2	76,2				
ABS.COL.										50 + 50	8,2	20	5,0			0,0	0,4	16,6	12,2					

AS TABLE 63

EXPERIMENT 13: MICROFILTRATION

FEED: 135L FROM EXP 13 CARBONATION

TIME (h-min)	SAMPLE	VOL (l)	PERM. RECOVERY (%)	FLUX (l/m2/h)	SAMPLE ANALYSIS													POINT REJECTION (%)									
					pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	COD (g/l)	Na (g/l)	Ca (mg/l)	Mg (mg/l)	$CO_3^=$ (g/l)	HCO_3^- (g/l)	TOT. CO_2 (g/l)	TS (g/l)	COND	TC	IC	OC	COD	Na	Ca	Mg	TOT. CO_2	TS
	FEED	135																									
	PERM	0	0																								
	PERM	80	59																								
	FEED				8.5	22	8.5	3.6	4.9		7.9	84.0	9.2	0.0	17.4	12.6	27.6										
	PERM	130	96	1.4	9.2	24	3.9	2.5	1.4		7.4	12.0	2.0	5.0	8.8	10.0	20.4	0	54	31	71		6	86	78	21	26

COMMENTS:

COMPANY:

AS TABLE 64

EXPERIMENT 13: NANOFILTRATION

FEED: 50L FROM EXP 13 CROSS-FLOW MICROFILTRATION, TOTAL FEED = 125L

TIME (h-min)	SAMPLE	VOL (l)	PERM. RECOVERY (%)	FLUX (l/m2/h)	SAMPLE ANALYSIS pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	COD (g/l)	Na (g/l)	Ca (mg/l)	Mg (mg/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	TS (g/l)	POINT REJECTION (%) COND	TC	IC	OC	COD	Na	Ca	Mg	TOT. CO2	TS
0.00	FEED	40			9.2	23	4.2	4.3	0.8		7.4	25.0	3.5	5.4	6.8	8.9	18.9										
	PERM	0	0	5.5 @ 20C	9.0	17	2.7	2.6	0.1		5.1	9.3	1.5	4.2	3.8	5.8	12.0	27	36	24	88		31	63	53	35	37
2.35	PERM	10	25	7.8 @ 44C																							
5.00	PERM	20	50	9.2 @ 50C																							
6.40	PERM	30	75	8.6 @ 48C																							
AT THIS STAGE 45L OF FEED WAS ADDED																											
6.40	PERM	30	35	5.3 @ 21C																							
10.10	PERM	40	47	8.9 @ 49C																							
12.10	PERM	50	59	9.6 @ 57C																							
13.40	PERM	60	71	9.7 @ 62C																							
ADDED A FURTHER 5L OF FEED																											
14.40	PERM	65	66																								
ADDED A FURTHER 35L OF FEED																											
14.40	PERM	65	52	5.1 @ 25C																							
17.05	PERM	75	60	9.1 @ 53C																							
21.00	FEED	5			9.7	48	18.8	6.2	12.6		19.6	143	31	17.5	12.6	21.9	70.5										
	PERM	95	76	5.2	9.6	43	6	5.9	0.1		16.5	15	5	14.4	11	18.5	44	11	68	5	99		16	90	84	16	38

COMMENTS: EVAPORATIVE LOSS 25L

A5 TABLE 65

EXPERIMENT NO 13: ELECTROLYSIS OF EFFLUENT SAMPLE A

ANOLYTE : 30 L FROM EXP 13 NF
CATHOLYTE : 15L NAOH
ABSORBTION COL : 30 L SCOUR EFFLUENT, TOTAL = 45 L.

SAMPLE	TIME (h-min)	CURRENT DENSITY (A/sq.m)	FARADAY PASSED (F)	VOLTAGE (V) OVERALL	CELL	MEMBRANE	C-M	A-M	TEMP. CELSIUS	VOLUME (l)	SAMPLE ANALYSIS pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	OH- (g/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	Na+ (g/l)	Ca++ (mg/l)	Mg++ (mg/l)	COD (g/l)	TS (g/l)
ANOLYTE	0,00	80	0,0	5					20	30,0	9,4	15	2,2	1,6	0,5	0,0	3,0	6,2	6,7	5,3	9	2	0,5	
CATHOLYTE		600		12,6	4,4	0,25	1,2	2,9		15,0		23				40,0	3,0	0,0	2,2	64,4				
					8,2	0,16	1,4	6,4																
ABS.COL.		800		16,8						30,0	12,7	37	2,3	0,3	2,0	2,4	2,0	0,0	1,4	5,5	24	4		
		1000		20,6																				
		1200		25,4																				
		600		12,6																				
ANOLYTE	4,05	600	4,6	15,3		0,47			47	28,2	5,9	7	0,8	0,3	0,5	0,0	1,2	4,4	4,1	2,1				
						0,15																		
CATHOLYTE		400		10,7						16,1						43,4	3,0	0,0	2,2	67,7				
ABS.COL.										30,0	9,9	17	2,5	1,0	1,5	0,0	5,6	0,9	4,7	5,7				
ABS.COL.	6,30	400	6,3	15,4					53		8,2													
AT THIS STAGE 15 L OF SCOUR EFFLUENT WAS ADDED TO THE ABSORPTION COLUMN : TOTAL = 45 L.																								
ABS.COL.		300		12,2	4,7	0,41	0,9	3,4			9,3													
					7,7	0,33	0,9	6,4																
ANOLYTE	7,40	300	7,0	15,4		0,19			51	27,7	4,8	2	0,3	0,2	0,1	0,0	0,0	0,9	0,7	0,4	2	0	0,4	
						0,16																		
CATHOLYTE										16,7		24				43,0	3,0	0,0	2,2	67,7				
ABS.COL.										30,0	10,0	17	2,4	0,6	1,8	0,0	5,2	2,0	5,2	5,0				

AS TABLE 66

EXPERIMENT NO 13 : ELECTROLYSIS OF EFFLUENT SAMPLE B

ANOLYTE : 30 L FROM EXP 13 NF
CATHOLYTE : 15L NAOH
ABSORBTION COL : 45 L FROM EXP 13 CELL A + 15 L SCOUR EFFLUENT

SAMPLE	TIME (h-min)	CURRENT DENSITY (A/sq.m)	FARADAY PASSED (F)	VOLTAGE (V) OVERALL	VOLTAGE (V) CELL	VOLTAGE (V) MEMBRANE	VOLTAGE (V) C-M	VOLTAGE (V) A-M	TEMP. CELSIUS	VOLUME (l)	SAMPLE ANALYSIS pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	OH- (g/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	Na+ (g/l)	Ca++ (mg/l)	Mg++ (mg/l)	COD (g/l)	TS (g/l)
ANOLYTE	0,00	120	0,0	5,1					23	30,0	9,4	21	3,3	2,5	0,7	0,0	4,9	11,6	11,9	7,5	13	2		
CATHOLYTE		600		8,2						16,0		23				38,3	3,0	0,0	2,2	56,5				
ABS.COL.		900		12,1						60,0	12,5	29	2,3	0,6	2,2	1,6	4,2	0,0	3,0	5,5	28	3		
	0,05	900	0,1	15,1																				
		800		13,8	4,5	0,20	1,3	3,0																
					8,9	0,20	1,5	6,9																
ABS.COL.	3,26	800	4,9	15					47		11,3													
		600		11,7	4,0	0,20	1,0	2,8																
					7,5	0,30	1,1	6,3																
ANOLYTE	5,15	600	6,9	15,4	3,9	0,15	0,9	2,8	50	27,9	8,2	11	1,3	0,1	1,2	0,0	0,0	7,8	5,6	3,1				
					7,5	0,13	1,0	6,3																
CATHOLYTE		400		10,8						16,4						45,9	3,0	0,0	2,2	57,6				
ABS.COL.										60,0	9,9	19	2,8	1,6	1,2	0,0	6,2	2,0	5,9					
	7,38	400	8,7	15					54															
		300		11,6	4,4	0,20	0,9	3,2																
					7,2	0,30	1,0	6,0																
ANOLYTE	9,30	300	9,7	15		0,20			54	26,1	5,6	2	0,4	0,0	0,4	0,0	0,0	1,0	0,7	0,4	1	0		
						0,10																		
CATHOLYTE										14,6		27				45,9	3,0	0,0	2,2	61,2				
ABS.COL.										60,0	9,3	18	3,0	1,2	1,8	0,0	3,6	6,1	7,0					

COMMENTS: NOTE: DURING THIS EXPERIMENT THERE WAS A LEAK IN THE CATHOLYTE PUMP CAUSING A VOLUME DECREASE.

DATE:

AS TABLE 67

EXPERIMENT NO 13 : ELECTROLYSIS OF EFFLUENT SAMPLE C

ANOLYTE : 30 L FROM EXP 13 MF
CATHOLYTE : 12L NAOH
ABSORPTION COL : 60 L FROM EXP 13 CELL B, TOTAL = 90 L.

SAMPLE	TIME (h-min)	CURRENT DENSITY (A/sq.m)	FARADAY PASSED (F)	VOLTAGE (V) OVERALL	VOLTAGE (V) CELL	VOLTAGE (V) MEMBRANE	VOLTAGE (V) C-M	VOLTAGE (V) A-M	TEMP. CELSIUS	VOLUME (l)	SAMPLE ANALYSIS pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	OH- (g/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	Na+ (g/l)	Ca++ (mg/l)	Mg++ (mg/l)	COD (g/l)	TS (g/l)
ANOLYTE	0,00	60	0,0	4,1					22	30,0	9,4	25	3,6	3,4	0,2	0,0	6,0	7,4	9,6	7,8	12	2		
CATHOLYTE		400		6,8						12,0		22				41,7	3,0	0,0	2,2	57,6				
ABS.COL.		800		9,3	4,4	0,18	1,2	2,9		60,0	9,4	13	2,8	2,0	0,8	0,0	5,0	4,4	6,8	5,6	34	3		
					8,6	0,20	1,5	6,6																
ABS.COL.	3,47	800	5,6	15					49		8,7													
		600		11,6		0,10																		
						0,10																		
ANOLYTE	4,17	600	6,1	11,8					50	28,3	7,7	14	1,3	0,8	0,5	0,0	3,2	3,2	4,6	1,8				
CATHOLYTE										13,4						43,0	3,0	0,0	2,2	58,4				
ABS.COL.										60,0	8,6	18	3,5	2,1	1,4	0,0	3,4	7,8	8,1					
AT THIS STAGE 60 L OF CARBONATED EFFLUENT WAS TRANSFERRED TO THE CROSS-FLOW MICROFILTRATION. 30 L OF SCOUR EFFLUENT WAS ADDED TO THE ABS.COL.																								
ABS.COL.	6,03	600	8,1	15,1		0,10			50		12,3													
						0,10																		
		400		10,5	3,9	0,10	0,9	2,8																
					6,9	0,10	1,0	5,8																
	6,12	400		15																				
		300		10,8																				
ANOLYTE	9,27	300	10,5	12,6	5,0	0,38	1,0	3,5	50	26,0	5,8	3	0,8	0,1	0,7	0,0	0,0	1,8	1,3	0,7	4	1		
					7,6	0,31	0,9	6,2																
CATHOLYTE										12,7		24				4,3	3,0	0,0	2,2	60,3				
ABS.COL.										60 + 60	10,0													

AS TABLE 68

EXPERIMENT 14: MICROFILTRATION

FEED: 75L FROM EXP 12A + 20L FROM EXP 12B , TOTAL FEED = 155L

TIME (h-min)	SAMPLE	VOL (l)	PERM. RECOVERY (%)	FLUX (l/m2/h)	SAMPLE ANALYSIS pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	COD (g/l)	Na (g/l)	Ca (mg/l)	Mg (mg/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	TS (g/l)
0.00	FEED	95			8.2	14	2.4	1.7	0.7	4.3	5.6	36.4	3.1	0.0	9.4	6.8	13.1
	PERM	0	0	2.5	8.8	14	1.8	1.6	0.2		3.9	13.1	2.1	1.7	6.1	5.6	11.5
				@ 200KP													
				@ 32C													
3.37	PERM	5	5														
17.27	PERM	20	21														
27.27	PERM	35	37														
41.47	PERM	55	58														
48.20	AT THIS STAGE 60L OF ABSORPTION COLUMN EFFLUENT FROM EXP 13C WAS ADDED																
53.25	PERM	63	39														
76.08	PERM	75	49														
98.07	PERM	85	55	2.7													
				@ 200KP													
				@ 39C													
162.27	FEED	10			7.6	30	40.5	2.9	37.6		14.3	650.0	62.0	0.0	32.0	23.1	56.7
	PERM	115	74		9.6	32	4.8	3.7	1.1		11.5	13.9	2.4	8.6	7.1	11.4	28.3

TIME (h-min)	SAMPLE	POINT REJECTION (%) COND	TC	IC	OC	COD	Na	Ca	Mg	TOT. CO2	TS
0.00	FEED										
	PERM	0	25	6	71		30	64	32	18	12
162.27	FEED										
	PERM	0	88	0	97		20	98	96	51	50

COMMENTS: EVAPORATIVE LOSS 30L

AS TABLE 69

EXPERIMENT 14: NANOFILTRATION

FEED: 55L FROM EXP 14 CROSS-FLOW MICROFILTRATION, TOTAL FEED = 115L

TIME (h-min)	SAMPLE	VOL (l)	PERM. RECOVERY (%)	FLUX (l/m2/h)	SAMPLE ANALYSIS pH	COND (mS/cm)	TC (g/l)	TC (g/l)	OC (g/l)	COD (g/l)	Na (g/l)	Ca (mg/l)	Mg (cg/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	TS (g/l)	POINT REJECTION (%) COND	TC	IC	OC	COD	Na	Ca	Mg	TOT. CO2	TS
0.00	FEED	55			9.2	15	2.3	1.7	0.6		4.4	15.2	2.7	3.0	4.1	5.2	11.7										
	PERM	0	0	6 @ 1,6MP @ 21C	8.9	11	1.8	1.1	0.7		2.9	7.1	1.3	1.3	4.5	4.2	7.4	31	22	35	0		34	53	52	19	37
4.59	PERM	20	36	9,3 @ 1,6MP @ 49C																							
8.40	PERM	30	55	9,2 @ 1,6MP @ 48C																							
9.34	PERM	45	82	6,2 @ 1,4MP @ 54C																							
AT THIS STAGE A FURTHER 30L OF FEED WAS ADDED																											
9.34	PERM	45	53	5,9 @ 1,6MP @ 20C																							
11.34	PERM	50	59	8,6 @ 1,6MP @ 47C																							
14.55	PERM	68	80	3,0 @ 1,2MP @ 53C																							
AT THIS STAGE A FURTHER 30L OF FEED WAS ADDED																											
14.55	PERM	68	59	5,7 @ 1,6MP @ 24C																							
18.20	PERM	78	68	10 @ 1,6MP @ 56C																							
21.15	FEED	5			9.8	43	13.0	6.0	7.0		16.9	30.5	15.5	14.2	8.2	16.3	52.8										
	PERM	93	81	3.3 @ 0,8MP @ 57C	9.8	40	5.5	0.7	4.8		14.8	21.1	8.6	13.9	5.9	14.4	37.8	7	58	88	31		12	31	45	12	28

COMMENTS: EVAPORATIVE LOSS 17L

A5 TABLE 7G

EXPERIMENT NO 14 : ELECTROLYSIS OF EFFLUENT SAMPLE A

ANOLYTE : 35 L FROM EXP 14 NF
CATHOLYTE : 15L NAOH
ABSORBTION COL : 35 L SCOUR EFFLUENT

SAMPLE	TIME (h-min)	CURRENT DENSITY (A/sq.m)	FARADAY PASSED (F)	VOLTAGE (V) OVERALL	CELL	MEMBRANE	C-M	A-M	TEMP. CELSIUS	VOLUME (l)	SAMPLE ANALYSIS pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	OH- (g/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	Na+ (g/l)	Ca++ (mg/l)	Mg++ (mg/l)	COD (g/l)	TS (g/l)
ANOLYTE	0,00	60	0.0	4,9					24	35,0	9,3	15	1,9	1,3	0,6	0,0	3,1	4,0	5,2	4,4	9	2		
CATHOLYTE		500		8,8						15,0		23				41,7	3,0	0,0	2,2	62,0				
ABS.COL.		800		12,3						35,0	12,3	28	1,8	0,2	1,6	1,6	1,2	0,0	0,9	3,6	28	3		
		1000		15,4																				
		1200		17,9																				
	0,35	600		12,7	4,5	0,40	1,1	2,9																
					8,6	0,18	1,4	7,3																
ANOLYTE	2,05	600	2,3	12,4	4,3	0,38	0,9	3,0	41	34,3	7,2	11	2,0	1,4	0,6	0,0	0,0	7,8	5,6	3,1				
					7,8	0,16	1,2	6,5																
CATHOLYTE										15,4						40,8	3,0	0,0	2,2	63,1				
ABS.COL.										35,0	12,5	21	1,9	0,3	1,6	0,9	2,8	0,0	2,0					
ABS.COL.	2,56	600	3,2	15,1					46		11,9													
		400		10,6	3,8	0,31	0,0	2,6																
					6,5	0,18	1,1	5,9																
ABS.COL.	6,53	400	6,1	15,1					55		8,9													
		300		11,8	4,3	0,20	1,0	3,0																
					7,6	0,28	1,0	6,3																
ANOLYTE	8,19	300	6,9	13,5	4,8	0,24	1,0	3,6	53	31,2	6,3	3	0,6	0,4	0,2	0,0	0,0	1,7	1,2	0,7	1	0,2		
					8,1	0,62	0,6	6,7																
CATHOLYTE										13,8		24				40,0	3,0	0,0	2,2	63,7				
ABS.COL.										35,0	8,5	13	2,1	1,7	0,5	0,0	1,7	9,0	6,5					

COMMENTS: NOTE: THE CATHOLYTE PUMP WAS LEAKING DURING THIS EXPERIMENT, HENCE THE DECREASE IN THE CATHOLYTE VOLUME

DATE:

AS TABLE 71

EXPERIMENT NO 14 : ELECTROLYSIS OF EFFLUENT B

ANOLYTE : 30 L FROM EXP 14 NF
CATHOLYTE : 15L NAOH
ABSORBTION COL : 35L FROM EXP. 14 CELL A + 25L SCOUR EFFLUENT

SAMPLE	TIME (h-min)	CURRENT DENSITY (A/sq.m)	FARADAY PASSED (F)	VOLTAGE (V) OVERALL	CELL	MEMBRANE	C-M	A-M	TEMP. CELSIUS	VOLUME (l)	SAMPLE ANALYSIS pH	COND (mS/cm)	TC (g/l)	TC (g/l)	OC (g/l)	OH- (g/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	Na+ (g/l)	Ca++ (mg/l)	Mg++ (mg/l)	COD (g/l)	TS (g/l)
ANOLYTE	0,00	60	0,0	4,8					26	30,0	9,5	16	2,6	1,7	0,9	0,0	4,1	3,4	5,4	5,0	10	2		
CATHOLYTE		600		8,8						15,0		22				36,6	3,0	0,0	2,2	55,4				
ABS.COL.		800		11,1						60,0	10,4	13	2,8	0,7	2,1	0,9	3,4	0,0	2,4	3,9	25	1		
		900		13,7	5,1	0,22	1,3	3,5																
					8,6	0,16	1,5	7,0																
	0,30	CATHOLYTE PUMP WAS LEAKING. STOPPED EXPERIMENT TO FIX PUMP.																						
	1,50	RESTARTED EXPERIMENT.																						
		900	0,8	15					32															
		800		13,5	4,9	0,20	1,3	3,3																
ABS.COL.					8,4	0,20	1,3	6,6																
ANOLYTE	3,52	800	3,7	15,4					47	29,3	7,1	10,2	1,3	0,4	0,9	0,0	3,6	0,5	3,0	3,0				
CATHOLYTE		600		11,9	4,5	0,26	1,0	3,2		15,7							3,0	0,0	2,2	60,3				
					7,0	0,42	1,0	5,6																
ABS.COL.										60,0	9,6	12,4	3,3	0,6	2,7	0,0	3,6	1,8	3,9					
ABS.COL.	5,28	600	5,5	15					50		9,0													
		400		10,9	4,6	0,18	1,0	3,4																
					6,3	0,43	1,0	5,2																
	6,54	400	6,5	15,3					47		8,9													
		300		12,2	5,3	0,40	1,0	3,9																
					7,1	0,40	1,0	5,7																
ANOLYTE	7,43	300	7,0	15,3	6,2	0,45	1,0	4,7	45	27,9	5,7	2	0,6	0,2	0,4	0,0	0,0	2,1	1,5	0,4	1	0,1		
					8,6	0,51	1,0	7,1																
CATHOLYTE										16,2		24				39,1	3,0	0,0	2,2	59,4				
ABS.COL.										60,0	8,3	13	3,7	0,9	2,8	0,0	0,0	9,2	6,6					

AS TABLE 72

EXPERIMENT NO 14 : ELECTROLYSIS OF EFFLUENT SAMPLE C

ANOLYTE : 35 L FROM EXP 14 NF
CATHOLYTE : 15L NaOH
ABSORBTION COL : 35L SCOUR EFFLUENT

SAMPLE	TIME	CURRENT DENSITY	FARADAY PASSED	VOLTAGE (V)					TEMP. CELSIUS	VOLUME	SAMPLE ANALYSIS													
	(h-min)	(A/sq.m)	(F)	OVERALL	CELL	MEMBRANE	C-M	A-M		(l)	pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	OH- (g/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	Na+ (g/l)	Ca++ (mg/l)	Mg++ (mg/l)	COD (g/l)	TS (g/l)
ANOLYTE	0,00	60	0,0	4,9					22	35,0	9,3	14	2,9	1,8	1,1	0,0	4,3	4,6	6,4	5,7	7	2		
CATHOLYTE		500		8,3						15,0		23				34,9	3,0	0,0	2,2	49,8				
ABS.COL.		600		13,6	4,4	0,28	1,1	2,9		35,0	12,8	45	1,9	0,2	1,7	0,0	1,6	0,0	1,2	5,8	29	2		
					9,6	0,24	1,4	8,0																
		700		15,3																				
ANOLYTE		800		12,1																				
CATHOLYTE		1000		17,9																				
ANOLYTE	2,04	600	2,3	13,7	4,2	0,30	0,9	2,9	40	33,9	6,4	14	2,6	1,7	0,9	0,0	2,3	5,1	5,5	4,0				
					9,5	0,10	1,3	7,7																
CATHOLYTE										15,5						38,9	3,0	0,0	2,2	52,1				
ABS.COL.										35,0	13,4	38	2,5	0,3	2,2	2,5	1,9	0,0	1,4					
	2,55	600	3,2	15																				
		500		12,6	4,0	0,40	0,9	2,7	44		11,4													
					8,3	0,15	1,2	7,9																
ABS.COL.	4,15	500	4,4	15					40															
		400		11,9	3,9	0,39	0,9	2,6																
					8,1	0,20	1,2	6,7																
ABS.COL.	6,29	400	6,0	15					45		5,5													
ABS.COL.		300		11,8	3,9	0,35	0,9	2,6																
					8,0	0,28	1,1	6,5																
ANOLYTE	9,40	300	7,6	15,2	4,7	0,30	1,0	3,3	40	31,5	9,8	4	0,7	0,3	0,4	0,0	0,0	3,2	2,3	1,0	1	0,3		
					10,2	0,40	1,1	8,5																
CATHOLYTE										16,4		22				37,4	3,0	0,0	2,2	58,8				
ABS.COL.										35,0	9,7	17	4,6	1,0	3,6	0,0	4,7	3,7	6,0					

A5 TABLE 73

EXPERIMENT NO 15 : CARBONATION

ANOLYTE : 30 L FROM EXP 13 CARBONATION + 1KG NAHCO3
CATHOLYTE : 15L NAOH
ABSORBTION COL : 30 L FROM EXP 13 CELL C + 30 L SCOUR EFFLUENT, TOTAL = 120 L.

SAMPLE	TIME (h-min)	CURRENT DENSITY (A/sq.m)	FARADAY PASSED (F)	VOLTAGE (V) OVERALL	CELL	MEMBRANE	C-M	A-M	TEMP. CELSIUS	VOLUME (l)	SAMPLE ANALYSIS pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	OH- (g/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	Na+ (g/l)	Ca++ (mg/l)	Mg++ (mg/l)	COD (g/l)	TS (g/l)
ANOLYTE	0,00	60	0,0	4,2					23	30,0	8,6	44	8,0	6,4	1,6	0,0	12,5	19,2	23,2	18,3	4	1		
CATHOLYTE		1000		9						15,0		19				31,5	3,0	0,0	2,2	50,6				
ABS.COL.		2500		18,6	6,2	0,20	1,6	4,2		60,0	12,4	26	3,1	0,9	2,2	1,0	4,7	0,0	3,4	5,3	32	2		
					11,3	0,20	2,2	7,5																
ABS.COL.	1,32	2500	6,9	16,8					48		9,4													
		2000		13,2	4,5	0,30	1,0	3,0																
					8,3	0,20	1,7	6,2																
ANOLYTE	2,35	2000	10,9	15,1					45	28,0	7,7	35	7,8	6,9	0,9	0,0	1,2	30,0	23,0	12,0				
CATHOLYTE										17,0						35,7	3,0	0,0	2,2	60,0				
ABS.COL.										60,0	7,9	17	4,6	2,7	1,9	0,0	0,0	13,5	10,0					
TRANSFERRED 60 L FROM ABS.COL. TO CROSS-FLOW MICROFILTRATION. ADDED A FURTHER 60 L SCOUR EFFLUENT TO ABS.COL.																								
ABS.COL.	2,53	2000	12,0	16							12,0													
		1500		11,7		0,28																		
						0,19																		
ABS.COL.	5,29	1500	19,2	19,3					55		9,6													
		1300		17		0,10																		
						0,20																		
ANOLYTE	7,13	1300	22,7	25,3		0,11			58	24,2	6,9	2	0,3	0,2	0,1	0,0	0,0	2,1	1,5	0,4				
						0,25																		
CATHOLYTE		400		22,8						18,5						43,3	3,0	0,0	2,2	67,0				
ABS.COL.		320		25,3						60 + 60	8,8	17	4,3	2,7	1,6	0,0	2,3	9,2	8,0					
AT THIS STAGE 200G OF NAHCO3 WAS ADDED TO THE ANOLTE AND THE EXPERIMENT WAS CONTINUED THE FOLLOWING DAY.																								
	8,30	60	23,4	4,9					24	15														
		600		13.9						18														
		1000		16,5	5,4	0,30	1,3	3,8		60														
					10,6	0,40	1,5	8,6																
		1200		21,3																				
ANOLYTE	9,40	1000	25,4	23,5	5,9	0,38			44	14,3	6,1	6	0,8	0,7	0,1	0	2,3	8,7	17,2	1,6	2	0,5		
					8,8	0,31				18,6		24				45,9	3,0	0	2,2	63,5				
CATHOLYTE										60 + 60	8,1	17	4,8	2,8	2	0	0	26,5	19,1					
ABS.COL.																								

AS TABLE 74

EXPERIMENT 15 : MICROFILTRATION

FEED: 120 L FROM EXPERIMENT 15 CARBONATION

TIME (h-min)	SAMPLE	VOL (l)	PERM. RECOVERY (%)	FLUX (l/m2/h)	SAMPLE ANALYSIS pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	COD (g/l)	Na (g/l)	Ca (mg/l)	Mg (mg/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	TS (g/l)
0.00	FEED	120			8.2	17	6.3	2.7	3.6	4.6	6.1	28.0	3.6	1.1	11.1	8.8	16.2
	PERM	0	0	3.00	9.0	18	3.6	2.6	1.0		5.8	16.0	2.8	2.8	8.1	7.9	14.2
				@ 200KP													
15.10	PERM	10	8														
24.41	PERM	25	21														
39.30	PERM	45	38	1.80													
				@ 200KP @ 38C													
48.45	PERM	60	50	2.40													
				@ 140KP @ 37C													
63.40	PERM	75	63	2.70													
				@ 200KP @ 41C													
72.10	PERM	85	71	2.30													
				@ 140KP @ 40C													
87.10	AT THIS STAGE THE EXPERIMENT STOPPED DUE TO ELECTRICAL FAULT BUT WAS RESTARTED																
95.20	FEED	10			9.4	25	17.3	2.2	15.1		10.0	216.0	22.0	5.5	11.8	12.5	41.7
	PERM	95	79	2.30	9.5	29	5.9	3.3	2.6		10.2	18.0	3.6	7.9	9.5	12.6	25.3

TIME (h-min)	SAMPLE	POINT REJECTION (%) COND	TC	IC	OC	COD	Na	Ca	Mg	TOT. CO2	TS
0.00	FEED										
	PERM	0	43	4	72		5	43	22	10	12
95.20	FEED										
	PERM	0	66	0	83		0	92	84	0	39

COMMENTS: EVAPORATIVE LOSS +- 15 L

AS TABLE 75

EXPERIMENT 15: NANOFILTRATION

FEED: 45 L FROM EXPERIMENT 15 CROSS-FLOW MICROFILTRATION

TIME (h-min)	SAMPLE	VOL (l)	PERM. RECOVERY (%)	FLUX (l/m2/h)	SAMPLE ANALYSIS													POINT REJECTION (%)									
					pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	COD (g/l)	Na (g/l)	Ca (mg/l)	Mg (mg/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	TS (g/l)	COND	TC	IC	OC	COD	Na	Ca	Mg	TOT. CO2	TS
0.00	FEED	45			9.0	18	2.9	1.9	1.0		5.7	17.8	2.8	2.3	8.7	8.0	14.1										
	PERM			6.6	8.8	13	2.3	1.9	0.4		4.1	7.1	1.2	1.0	7.6	6.2	9.5	26	21	0	60		28	60	57	23	33
				@ 1.6MP @ 23C																							
2.25	PERM	10	22	9.7																							
				@ 1.8MP @ 45C																							
4.20	PERM	20	44	9.6																							
				@ 1.6MP @ 52C																							
6.40	PERM	30	67	10.2																							
				@ 1.6MP @ 53C																							
8.17	PERM	40	89	4																							
				@ 1MP @ 45																							
ADDED FURTHER 30 L FROM EXPERIMENT 15 CROSS-FLOW MICROFILTRATION, TO FEED																											
8.17	PERM	40	53	6.1																							
				@ 1.6MP @ 24C																							
12.52	PERM	60	63	9.5																							
				@ 1.6MP @ 58C																							
13.40	PERM	63	66	4																							
				@ 0.8MP @ 56C																							
ADDED FURTHER 20 L FROM EXPERIMENT 15 CROSS-FLOW MICROFILTRATION, TO FEED																											
13.4	PERM	63	55	5.1																							
				@ 1.6MP @ 22C																							
18	FEED	5			9.7	35	8.5	5.7	2.8		13.1	26.5	5.6	10.4	10.4	15.1	36.0										
	PERM	81	70	4.9	9.6	29	5.5	4.5	1.0		10.0	10.4	2.8	0.8	15.5	11.8	25.4	17	35	21	64		24	61	50	22	29
				@ 1MP @ 52C																							

COMMENTS: EVAPORATIVE LOSS +- 9L

AS TABLE 76

EXPERIMENT NO 15 ELECTROLYSIS OF EFFLUENT SAMPLE A

ANOLYTE : 30 L FROM EXP 15 NF
CATHOLYTE : 15L NAOH
ABSORBTION COL : 35 L FROM EXP 14 CELL C + 25 L SCOUR EFFLUENT

SAMPLE	TIME (h-min)	CURRENT DENSITY (A/sq.m)	FARADAY PASSED (F)	VOLTAGE (V)					TEMP. CELSIUS	VOLUME (l)	SAMPLE ANALYSIS													
				OVERALL	CELL	MEMBRANE	C-M	A-M			pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	OH- (g/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	Na+ (g/l)	Ca++ (mg/l)	Mg++ (mg/l)	COD (g/l)	TS (g/l)
ANOLYTE	0,00	60	0,0	5,1					25	30,0	9,4	16	2,4	1,7	0,7	0,0	2,4	7,8	7,3	5,4	9	2		
CATHOLYTE		500		14,5	4,3	0,21	1,2	2,7		15,0						32,3	3,0	0,0	2,2	50,0				
					9,0	0,18	1,3	6,9																
ABS. COL.		600		16,8						60,0	11,9	19	3,1	1,0	2,1	0,0	5,5	0,0	4,0	5,4	30	1		
		700		19,2																				
		800		20,9																				
ANOLYTE	2,03	500	1,8	11,2	4,1	0,28	1,1	2,6	43	29,3	7,7	12,3	2,4	2,0	0,4	0,0	0,0	8,7	6,3	3,5				
					7,4	0,14	1,2	5,8																
CATHOLYTE										15,5						34,0	3,0	0,0	2,2	54,6				
ABS. COL.										60,0	12,0	18	3,1	1,1	2,0	0,4	5,9	0,0	4,2					
	4,27	500	4,0	15,1					50															
				12,2	4,1	0,30	1,0	2,7																
					8,0	0,15	1,1	7,0																
	5,53	400	5,0	15					48															
		300		11,3																				
ANOLYTE	7,15	300	5,8	14,4	4,7	0,40	1,0	3,2	45	27,3	6,5	3,5	0,5	0,0	0,5	0,0	0,2	1,0	0,9	0,8	1	0,4	0,6	
					9,7	0,2	1	8																
CATHOLYTE										16,3		26				36,6	3,0	0,0	2,2	58,9				
ABS. COL.										60,0	9,6	16	3,3	1,8	1,5	0,0	3,8	4,6	6,0					

AS TABLE 77

EXPERIMENT NO 15 : ELECTROLYSIS OF EFFLUENT SAMPLE B

ANOLYTE : 15 L FROM EXP 15 NF
CATHOLYTE : 15L NAOH
ABSORBTION COL : 60L FROM EXP. 15 CELL A

SAMPLE	TIME (h-min)	CURRENT DENSITY (A/sq.m)	FARADAY PASSED (F)	VOLTAGE (V)					TEMP. CELSIUS	VOLUME (l)	SAMPLE ANALYSIS													
				OVERALL	CELL	MEMBRANE	C-M	A-M			pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	OH- (g/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	Na+ (g/l)	Ca++ (mg/l)	Mg++ (mg/l)	COD (g/l)	TS (g/l)
ANOLYTE	0,00	60	0,0	5					25	30,0	9,1	16	2,6	1,6	1,0	0,0	2,6	7,4	7,2	5,2	9	2		
CATHOLYTE		400		8						15,0		16				22,5	3,0	0,0	2,2	40,0				
ABS.COL.		500		12,5	4,2	0,37	1,2	2,6		60,0	9,7	13	2,4	1,9	0,5	0,0	3,7	2,7	4,6	4,4	20	1		
					8,5	0,15	1,4	6,7																
		600		15,4																				
ABS.COL.	1,14	500	1,1	11					37		9,3													
		600		12,7	4,4	0,33	1,2	2,8																
					8,0	0,12	1,3	6,8																
ANOLYTE	2,00	600	2,0	13,4	4,5	0,32	1,0	2,9	44	29,7	6,7	12	2,5	1,8	0,7	0,0	1,2	6,1	5,3	3,5				
					8,6	0,10	1,3	7,0																
CATHOLYTE										15,5						28,1	3,0	0,0	2,2	42,5				
ABS.COL.										60,0	9,8		3,6	1,5	2,1									
	2,33	600	2,6	15					46															
		500		12	4,2	0,38	1,0	2,8																
					8,3	0,18	1,2	6,9																
ABS.COL.	3,59	500	3,9	15,5					48		8,7													
ANOLYTE		400		12,5	4,2	0,30	0,9	2,9																
					9,0	0,17	1,1	7,5																
ABS.COL.	5,22	400	4,9	15					52		8,4													
		300		12,4	4,3	0,40	0,9	3,0																
					8,2	0,15	1,0	7,0																
AT THIS STAGE 10 L WAS REMOVED FROM THE ABSORPTION COLUMN FOR THE CROSS-FLOW MICROFILTRATION.																								
ANOLYTE	6,34	300	5,5	15,4	5,0	0,40	0,9	3,7	49	27,2	5,9	3	0,5	0,3	0,2	0,0	0,4	0,5	0,6	0,8	2	0,4		
					9,6	0,10	1,0	8,7																
CATHOLYTE										15,3		20				30,6	3,0	0,0	2,2	45,1				
ABS.COL.										10 + 50	9,0	15	3,5	1,4	2,1	0,0	2,8	7,0	7,1					

A7 TABLE 78

EXPERIMENT NO 15 : ELECTROLYSIS OF EFFLUENT SAMPLE C

ANOLYTE : 24 L FROM EXP 15 MF
CATHOLYTE : 17L NAOH
ABSORBTION COL : 17 L SCOUR EFFLUENT

SAMPLE	TIME (h-min)	CURRENT DENSITY (A/sq.m)	FARADAY PASSED (F)	VOLTAGE (V)					TEMP. CELSIUS	VOLUME (l)	SAMPLE ANALYSIS													
				OVERALL	CELL	MEMBRANE	C-M	A-M			pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	OH- (g/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	Na+ (g/l)	Ca++ (mg/l)	Mg++ (mg/l)	COD (g/l)	TS (g/l)
ANOLYTE	0,00	60	0,0	5,8					22	24,0	9,5	14	2,3	1,4	0,9	0,0	3,1	4,0	5,1	4,5	7	1		
CATHOLYTE		400		11						17,0		16				28,9	3,0	0,0	2,2	45,1				
ABS.COL.		500		12,4						25,0	12,3	37	2,0	0,2	1,8	2,0	1,7	0,0	1,2	5,0	24	3		
		600		13,9																				
		800		16,7																				
	0,10	300	0,1	13,9																				
	0,15	300	0,1	16,9	4,2	0,18	1,0	2,7																
					12,3	0,18	1,3	10,5																
	1,30	INCREASED ELECTROLYE FLOWS: CATHOLYTE, FROM 15,3L/MIN TO 17L/MIN AND ANOLYTE, FROM 13,5L/MIN TO 15,3L/MIN																						
ANOLYTE	3,15	300	1,8	11,7	3,7	0,16	1,0	2,5	48	22,6	7,1	9,4	1,5	0,9	0,6	0,0	1,7	3,4	3,7	2,7				
					7,6	0,16	1,0	6,6																
CATHOLYTE										17,6						37,4	3,0	0,0	2,2	56,3				
ABS.COL										25,0	12,5	35	2,1	0,4	1,7	2,2	1,8	0,0	1,3					
	3,20	400	1,8	14,7	4,0	0,25	0,9	2,8																
					10,3	0,16	1,1	9,4																
	3,30	400	1,8	15,2																				
		300		11,9																				
ANOLYTE	7,30	300	4,0	15,1	7,1	0,10	1,0	6,1	55	20,0	5,9	3	0,5	0,3	0,2	0,0	0,0	1,6	1,2	0,7	2	0,2		
					7,4	0,20	0,9	6,3																
CATHOLYTE										19,1		23				40,0	3,0	0,0	2,2	56,0				
ABS.COL.										25,0	11,8	18	2,9	1,0	1,9	0,4	4,9	0,0	3,5					

AS TABLE 79

EXPERIMENT 16: MICROFILTRATION

FEED: 120 L FROM EXPERIMENTS 14 & 15 ELECTROLYSES

TIME (h-min)	SAMPLE	VOL (l)	PERM. RECOVERY (%)	FLUX (l/m2/h)	SAMPLE ANALYSIS pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	COD (g/l)	Na (g/l)	Ca (mg/l)	Mg (mg/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	TS (g/l)	POINT REJECTION (%) COND	TC	IC	OC	COD	Na	Ca	Mg	TOT. CO2	TS
0.00	FEED	120			8.3	13	3.4	1.0	2.4	3.5	5.0	35.0	1.5	0.2	9.6	7.1	11.0										
	PERM	0	0	0.5	8.6	11	2.2	0.8	1.4		3.3	23.6	2.0	0.4	7.1	5.4	8.1	19	35	20	42		34	33	0	24	26
				@ 200KP	@ 28C																						
62.25	PERM	50	42																								
93.55	PERM	80	67	1.2																							
				@ 200KP	@ 36C																						
110.28	FEED	10			8.5	23	15.0	3.3	11.7	35.3	7.8	125.0	34.0	1.9	16.0	12.9	35.8										
	PERM	110	92		9.8	21	3.4	2.3	1.1	1.9	6.4	20.0	0.9	5.3	5.7	8.0	16.5	9	77	30	91	95	18	84	97	38	54

COMMENTS:

COMPANY:

AS TABLE 80

EXPERIMENT 16: NANOFILTRATION

FEED: 50 L FROM EXPERIMENT 16 CROSS-FLOW MICROFILTRATION

TIME	SAMPLE	VOL	PERM. RECOVERY	FLUX	SAMPLE ANALYSIS													POINT REJECTION (%)									
(h-min)		(l)	(%)	(l/m2/h)	pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	COD (g/l)	Na (g/l)	Ca (mg/l)	Mg (mg/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	TS (g/l)	COND	TC	IC	OC	COD	Na	Ca	Mg	TOT. CO2	TS
0.00	FEED	50			9.6	16	2.1	1.5	0.6	0.8	4.6	19.2	0.9	4.0	3.3	5.3	6.7										
	PERM	0	0	5.1	9.7	7	0.9	0.8	0.1	0.1	2.4	5.1	0.6	1.8	2.2	2.9	5.5	59	57	47	83	91	48	73	33	45	18
				@ 1.6MP @ 18C																							
4.26	PERM	20	40	9.9																							
				@ 1.6MP @ 50C																							
6.15	PERM	30	60	10																							
				@ 1.6MP @ 55C																							
6.55				11.5																							
				@ 2.2MP @ 47																							
8.05	AT THIS STAGE THE APPARATUS WAS SWITCHED OFF.																										
8.05	PERM	40	80	5.1																							
				@ 1.6MP																							
8.20	ADDED FURTHER 20 L CROSS-FLOW MICROFILTRATE FROM EXPERIMENT 16, TO FEED																										
12.10	PERM	50	71	9.2																							
				@ 1.6MP @ 55C																							
14.10	PERM	62	89																								
ADDED FURTHER 40 L CROSS-FLOW MICROFILTRATE FROM EXPERIMENT 16, TO FEED																											
14.1	PERM	62	56	6.3	@ 1.6 MP AT 23C																						
16.1	PERM	72	66	10.2																							
				@ 1.8MP @ 47C																							
18.1	PERM	82	75	11.7																							
				@ 2.0MP @ 57C																							
19.3	FEED	5		9.9	9.9	34	8.5	1.9	6.6	9.0	11.9	59.0	2.6	10.6	9.6	14.7	34.2										
				@ 1.8MP @ 63C																							
	PERM	95	86		9.8	24	3.6	1.2	2.4	0.8	8.0	14.2	0.8	7.0	4.9	8.7	19.6	29	58	37	64	91	33	76	77	41	43

COMMENTS: EVAPORATE LOSS +- 10 L.

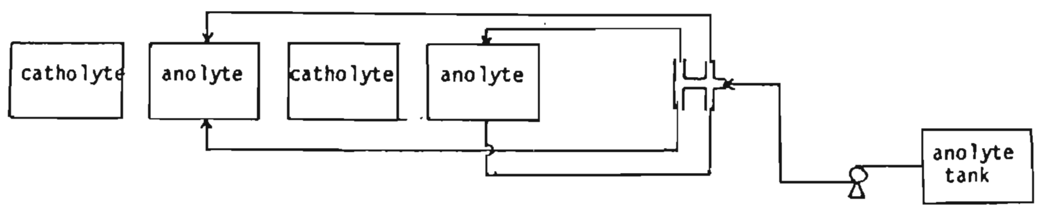
A5 TABLE 31

EXPERIMENT NO 16 : ELECTROLYSIS OF EFFLUENT SAMPLE A

ANOLYTE : 30 L FROM EXP 16 NF
CATHOLYTE : 18L NAOH
ABSORBTION COL : 25 L FROM EXP 15 CELL C + 5 L SCOUR EFFLUENT.

SAMPLE	TIME (h-min)	CURRENT DENSITY (A/sq.m)	FARADAY PASSED (F)	VOLTAGE (V) OVERALL	CELL	MEMBRANE	C-M	A-M	TEMP. CELSIUS	VOLUME (l)	SAMPLE ANALYSIS pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	OH- (g/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	Na+ (g/l)	Ca++ (mg/l)	Mg++ (mg/l)	COD (g/l)	TS (g/l)
ANOLYTE	0,00	60	0,0	5,1					24	30,0	9,3	13	1,9	1,4	0,5	0,0	3,8	2,6	4,6	4,0	9	0,6		
CATHOLYTE		300		9,3						18,0						33,3	3,0	0,0	2,2	51,8				
ABS.COL.		500		12,7						25,0	12,5	20	2,8	0,7	2,1	0,5	4,9	0,0	3,5	5,3	28	2		
		600		14,3	7,2	0,06	1,8	5,3																
					7,0	0,20	1,2	5,4																
		700		15,8																				
	1,17	600	1,3	14	7,0	1,50	1,4	4,1	38															
					6,9	0,50	0,7	5,5																
ANOLYTE	2,02	600	2,2	15	7,3	1,60	1,4	4,5	42	29,0	6,9	8	1,3	0,6	0,7	0,0	1,6	2,4	2,9	2,5				
					7,3	0,30	1,0	5,9																
CATHOLYTE										13,3						37,1	3,0	0,0	2,2	54,1				
ABS.COL.										25,0	10,0	14	2,9	1,4	1,5	0,0	4,2	3,5	5,5					
		400		11,5	5,7	1,60	1,3	2,9																
					5,7	0,30	0,9	4,5																
	4,34	400	3,8	15,7																				
		300		13,2	6,3	0,24	1,3	4,7	46															
					6,7	0,28	1,0	4,8																
ANOLYTE	5,07	300	4,1	15	7,1	0,30	1,2	5,5	45	26,4	6,5	3	0,5	0,3	0,2	0,0	0,4	1,3	1,2	0,9	1	0,2		
					7,6	1,50	0,9	5,3																
CATHOLYTE										19,0		22				40,4	3,0	0,0	2,2	54,6				
ABS.COL.										25,0	9,2	16	3,8	1,6	2,2	0,0	2,8	6,8	6,9					

COMMENTS: NOTE: PRIOR TO THIS EXPERIMENT THE FLOW CONFIGURATION TO THE CELLS WAS CHANGED FROM SERIES TO PARALLEL. IT WAS HOPED THE AMOUNT OF AIR BUBBLES TO THE SECOND CELL WOULD BE REDUCED, THUS LOWERING THE VOLT DROP
THE FLOW TO THE CELLS FROM THE MANIFOLDS IS SHOWN BELOW FOR THE ANOLYTE COMPARTMENTS ONLY



AS TABLE 82

EXPERIMENT NO 16 : ELECTROLYSIS OF EFFLUENT SAMPLE B

ANOLYTE : 30 L FROM EXP 16 NF
CATHOLYTE : 15L NAOH
ABSORBTION COL : 30 L FROM EXP 16 CELL A + 30 L SCOUR EFFLUENT

SAMPLE	TIME (h-min)	CURRENT DENSITY (A/sq.m)	FARADAY PASSED (F)	VOLTAGE (V) OVERALL	CELL	MEMBRANE	C-M	A-M	TEMP. CELSIUS	VOLUME (l)	SAMPLE ANALYSIS pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	OH- (g/l)	$CO_3^=$ (g/l)	HCO_3^- (g/l)	TOT. CO_2 (g/l)	Na^+ (g/l)	Ca^{++} (mg/l)	Mg^{++} (mg/l)	COD (g/l)	TS (g/l)
ANOLYTE	0,00	60	0,0	5,1					23	30,0	9,4	13	1,7	1,4	0,3	0,0	3,4	4,8	5,9	4,5	11	1		
CATHOLYTE		400		10,5						15,0		15				28,1	3	0	2,2	37,2				
ABS.COL.		600		13						60,0	12,0	15	2,7	0,8	1,9	0,4	2,5	0,0	1,8	5,2	28	1		
		700		14,4	7,4	0,30	1,7	5,1																
					7,2	0,30	0,9	5,7																
	0,05	500	0,9	12,7	6,1	0,30	1,8	4,1																
					6,1	0,60	0,9	4,6																
ANOLYTE	2,45	500	2,5	13,8	6,6	0,04	0,8	5,2	40	28,3	6,7	9	1,5	0,8	0,7	0,0	1,0	3,9	3,5	2,6				
					6,8	0,40	1,1	5,3																
CATHOLYTE										15,6						31,5	3,0	0,0	2,2	46,3				
ABS.COL.										60,0	10,7	14	3,0	1,0	2,0	0,0	0,0	5,5	0,5	4,4				
ABS.COL.	3,25	500	3,0	15	7,3	0,10	0,5	5,6	41		10,1													
					7,4	0,40	1,1	5,8																
		400		12,7	6,3	0,10	0,6	4,7																
					6,4	0,40	1,1	4,9																
ABS.COL.	4,45	400	3,9	15,4					38		9,8													
		300		13	6,3	0,20	0,4	5,2																
					6,6	0,30	1,0	4,9																
ANOLYTE	5,45	300	4,4	15,2	7,5	0,20	0,6	6,0	40	26,8	6,2	4	0,5	0,3	0,2	0,0	0,4	1,2	1,2	1,0	2	0,1		
					7,8	0,30	1,1	6,4																
CATHOLYTE										16,3		18				33,2	3,0	0,0	2,2	48,0				
ABS.COL.										60,0	9,8	14	3,2	1,7	1,5	0,0	2,2	3,9	4,4	48,0				

COMMENTS: THE SAME FLOW AND MANIFOLD CONFIGURATION AS IN EXP. 16A APPLIED HERE

DATE:

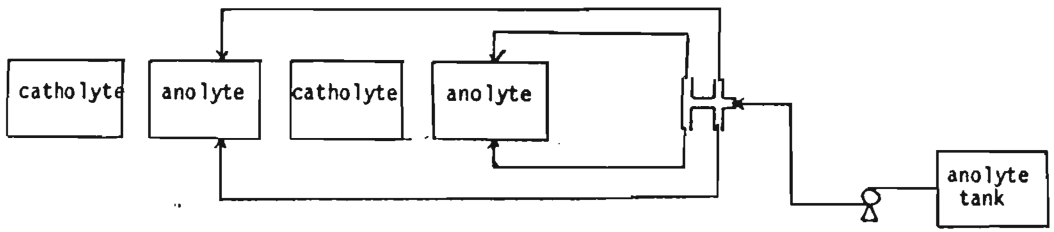
AS TABLE 83

EXPERIMENT NO 17 : CARBONATION

ANOLYTE : 20 L AT 90G/L $NAHCO_3$
CATHOLYTE : 15L NAOH
ABSORBTION COL : 60 L SCOUR EFFLUENT, TOTAL 120L

SAMPLE	TIME (h-min)	CURRENT DENSITY (A/sq.m)	FARADAY PASSED (F)	VOLTAGE (V) OVERALL	CELL	MEMBRANE	C-M	A-M	TEMP. CELSIUS	VOLUME (l)	SAMPLE ANALYSIS pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	OH^- (g/l)	$CO_3^{=}$ (g/l)	HCO_3^- (g/l)	TOT. CO_2 (g/l)	Na^+ (g/l)	Ca^{++} (mg/l)	Mg^{++} (mg/l)	COD (g/l)	TS (g/l)
ANOLYTE	0,00	60	0,0	4,8					21	20,0	8,1	47				0,0	0,0	52,6	37,9	21,0	3	2		
CATHOLYTE		400		6,8						15,0		19				34,0	3,0	0,0	2,2	52,5				
ABS.COL.		1000		10,3						60,0	12,9	43	0,7	0,4	0,3	2,8	1,8	0,0	1,3	6,0	2	2		
		1500		13,4																				
		2000		15,9	5,8	0,46	1,5	3,7																
					9,2	0,18	1,9	6,7																
ANOLYTE	2,34	2000	9,5	16,7					59	18,3	7,3	33				0,0	3,8	23,9	19,9	12,8				
CATHOLYTE										16,5						39,1	3,0	0,0	2,2	60,7				
ABS.COL.										60,0	9,3	17	3,4	2,0	1,4	0,0	3,2	6,7	7,1					
AT THIS STAGE 60 L OF EFFLUENT WAS TRANSFERRED FROM THE ABS.COL. TO CROSS FLOW MICROFILTRAATION. A FURTHER 60 L OF SCOUR EFFLUENT WAS ADDED TO THE ABS.COL.																								
	2,53	1200	10,6	10,5	3,7	0,24	1,0	2,4																
					6,6	0,16	1,5	4,9																
ANOLYTE	5,35	1200	16,5	20,1	4,8	0,21	1,0	3,6	61	16,1	7,5	11				0,0	1,6	5,1	3,7	1,6	1	1		
					15,6	0,22	1,5	12,9																
CATHOLYTE										17,8		25				42,5	3,0	0,0	2,2	64,6				
ABS.COL.										60 + 60	9,6	15	3,5	1,2	2,3	0,0	3,5	4,5	5,8					

COMMENTS: THE FLOW CONFIGURATION TO THE CELL STACK WAS IN PARALLEL BUT THE FIRST CELL WAS FED FROM THE ELECTROLYTE END OF EACH MANIFOLD.
THE FLOW TO THE TWO ANOLYTE COMPARTMENTS IS ILLUSTRATED BELOW. A SIMILAR SET-UP EXISTED FOR THE CATHOLYTE COMPARTMENTS.



AS TABLE 84

EXPERIMENT 17: MICROFILTRATION

FEED: 120 L CARBONATED EFFLUENT FROM EXPERIMENT 17 CARBONATION

TIME (h-min)	SAMPLE	VOL (l)	PERM. RECOVERY (%)	FLUX (l/m2/h)	SAMPLE ANALYSIS pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	COD (g/l)	Na (g/l)	Ca (mg/l)	Mg (mg/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	TS (g/l)	POINT REJECTION (%) COND	TC	IC	OC	COD	Na	Ca	Mg	TOT. CO2	TS
0.00	FEED	120			9.0	16	3.9	1.9	2.0		5.1	24.5	1.5	1.1	9.8	7.9	12.9										
	PERM	0	0	0.4	9.2	16	2.5	1.8	0.7		5.2	12.2	0.5	2.8	6.5	6.7	12.2	0	36	5	65		0	50	67	15	5
				@ 200KP	@ 30C																						
16.10	PERM	90	75	0.9																							
				@ 200KP	@ 45C																						
	FEED	15			8.0	17	21.4	2.7	18.7		7.2	288.0	58.0	0.0	16.1	11.6	43.8										
	PERM	105	88		9.4	24	4.6	2.9	1.7		7.5	28.0	1.4	4.6	9.6	10.3	19.9	0	79	0	91		0	90	98	11	55

COMMENTS: EVAPORATIVE LOSS = 5 L.

ANOLYTE : 40 L AT 112G/L NAHCO3
CATHOLYTE : 20 L NAOH
ABSORBTION COL : 60 L SCOUR EFFLUENT SPIKED AT 125G/L NAHCO3 (TOTAL = 120 l)

SAMPLE	TIME	CURRENT DENSITY	FARADAY PASSED	VOLTAGE (V)					TEMP. CELSIUS	VOLUME	SAMPLE ANALYSIS													
	(h-min)	(A/sq.m)	(F)	OVERALL	CELL	MEMBRANE	C-M	A-M		(l)	pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	OH- (g/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	Na+ (g/l)	Ca++ (mg/l)	Mg++ (mg/l)	COD (g/l)	TS (g/l)
THE INITIAL ABSORPTION COLUMN LIQUOR, PRIOR TO ADDITION OF THE NAHCO3 HAD THE FOLLOWING COMPOSITION:											13,3	77	51,0	0,1	5,0	5,7	2,8	0,0	2,0	10,3	17	10		24,2
ANOLYTE	0,00	60	0,0	4,4						40,0	8,8			12,2		0,0	3,5	65,8	54,2	25,5				
CATHOLYTE		300		6,6	3,2					20,0						26,4	4,5	0,0	3,3	39,8				
					3,5																			
ABS.COL.		600		8,6	4,0		2,5	2,9	26	60,0	9,4	73	21,0	16,3	4,7	0,0	31,0	59,4	66,0	41,9	12	8		
					4,2		2,7	2,8																
		1040		10,1																				
		1400		11,7																				
	1,10	1400	2,3	10,6																				
AT THIS STAGE THE ABSORPTION COLUMN PUMP FAILED AND THE EXPERIMENT WAS RESTARTED THE FOLLOWING DAY.																								
ANOLYTE	0,00	340	0,0	6,6						32,0	8,5			11,0		0,0	8,9	51,2	45,9	23,1				
CATHOLYTE		600		8,4						20,0						26,4	4,5	0,0	3,3	39,8				
ABS.COL.		1000		10,5						60,0	9,4	73	21,0	16,3	4,7	0,0	31,0	59,4	66,0	41,9	12	8		
		1400		12,6	6,5		1,7	3,1	22															
					6,5	0,02	1,9	2,9																
	0,30	1400	3,5	11,9	5,8			3,5	26	TURNED UP CURRENT														
					5,8			3,0																
		1700		13,1																				
	0,40	1700	4,5	12,5					30	TURNED UP CURRENT														
		2000		13,3																				
	2,10	2000	10,1	11,8	5,5		1,6	3,0	47															
					5,5		2,1	2,5																
	3,35	2000	15,6	11,5	5,5		1,6	3,2	56	TURNED CURRENT DOWN														
		1800		10,8	5,5		2	2,7																
					5,2																			
					5,0																			
ANOLYTE	4,45	1800	19,4	11,3	5,5				60	21,5	8,0	40				0	3	46,5	36,1	14				
					5,2																			
CATHOLYTE										28,8						33,2	15	0	11	40,6				
ABS.COL.										60	8,8	69	21,1	19,6	1,5	0	19,4	52	74					
TURNED CURRENT DOWN		1700		11,0	5,2																			
					5,0																			
AT THIS STAGE THE ABSORPTION COLUMN LIQUOR WAS REMOVED FOR CROSS FLOW MICROFILTRATION AND A SECOND BATCH OF EFFLUENT CONTAINING 125G/L NAHCO3 WAS ADDED TO THE ABSORPTION COLUMN.																								
ANOLYTE	6,4	1700	22,1	11,6	5,4		1,4	3,6	60	TURNED CURRENT DOWN														
					5,2		1,8	3,2																
		1500		11,1																				
	7,45	1500	25,4	13	5,6		1,4	4,3	59	TURNED CURRENT DOWN														
					5,3		1,5	4,6																
		1200		11,5																				
	8,05	AT THE STAGE 500G OF NAHCO3 WAS ADDED TO THE ANOLYTE: IE 137G NA + 363G HCO3.																						
	8,45	1400	30,1	9,6	4,1		2,3	2,4	64															
					4,5		2,4	3																
	9,45	1400	32,8	12,1	TURNED CURRENT DOWN																			
		1200		11,1																				
ANOLYTE	11,35	680	36,6	25,3	13			11,5	59	13,8	5,6	4		0,4		0	0	1,8	1,3	0,6				
					11			9,5																
CATHOLYTE										34,4						26,4	18		13,7	46,4				
ABS.COL.										60 + 60	8,7	70	30,1	22,2	8,4	0	17,4	39,3	41,4		38	4		

AS TABLE 86

EXPERIMENT 18: MICROFILTRATION

FEED: 120 L CARBONATED EFFLUENT FROM EXPERIMENT 18 CARBONATION

TIME	SAMPLE	VOL	PERM.	FLUX	SAMPLE ANALYSIS													POINT REJECTION (%)									
(h-min)		(l)	RECOVERY (%)	(l/m2/h)	pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	COD (g/l)	Na (g/l)	Ca (mg/l)	Mg (mg/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	TS (g/l)	COND	TC	IC	OC	COD	Na	Ca	Mg	TOT. CO2	TS
0.00	FEED	120			8.9	71				32.7	36.9	49.0	6.0	19.4	82.0	74.0	78.7										
	PERM	0	0	4	9.0	70					31.7	24.0	5.0	20.4	102.5	89.7	80.6	1					14	51	17	0	0
				@ 200KP @ 29C																							
LEFT OPERATING AT 100KP (OUTLET PRESSURE)																											
69.00	PERM	50	42																								
117.00	FEED	10			9.6	63					54.0	318.0	4.0	41.4	47.6	65.0	49.9										
	PERM	100	83	1.5	9.6	93					61.6	19.0	6.0	67.2	52.2	87.2	138.4	0					0	94	0	0	8
				@ 200KP @ 42C																							

COMMENTS: NaHCO3 HAD PRECIPITATED IN THESE SAMPLES AS A RESULT OF OVERSATURATION OF THE EFFLUENT TO THE ABSORPTION COLUMN WITH NaHCO3.

EVAPORATIVE LOSS = 10 L

AS TABLE 87

EXPERIMENT 18: Nanofiltration

Feed 100 L FROM EXPERIMENT 18 CROSS-FLOW MICROFILTRATION

TIME	SAMPLE	VOL	PERM. RECOVERY	FLUX	SAMPLE ANALYSIS													POINT REJECTION (%)									
(h-min)		(l)	(%)	(l/m2/h)	pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	COD (g/l)	Na (g/l)	Ca (mg/l)	Mg (mg/l)	$CO_3^{=}$ (g/l)	HCO_3^- (g/l)	TOT. CO_2 (g/l)	TS (g/l)	COND	TC	IC	OC	COD	Na	Ca	Mg	TOT. CO_2	TS
0.00	FEED	100			9.3	78					42.4	16.0	5.0	46.8	34.2	59.1	93.2										
	PERM	0	0	161	9.2	78					40.4	17.0	4.0	34.8	59.0	68.5	94.8	0					6	0	20	0	0
				@26C																							
2.00	PERM	20	20	58																							
				@34C																							
3.30	PERM	70	70	54																							
				@30C																							
3.55	FEED				9.5	89					56.5	24.0	9.0	61.9	140.8	148.0	135.6										
	PERM	88	88	19	9.5	89					54.0	6.0	5.0	41.4	64.8	64.8	124.9	0					18	75	44	55	8
				@0.8MPa																							
				@38C																							

COMMENTS: MEMBRANE USED:FROM SMITH AND NEPHEW PILOT PLANT STUDY

A5 TABLE 88

EXPERIMENT NO 18 : ELECTROLYSIS OF EFFLUENT SAMPLE A

ANOLYTE : 40 L OF PERM FROM EXP 18 NF
CATHOLYTE : 30L NAOH
ABSORBTION COL : 40 L SCOUR EFFLUENT + 167G/L NAHCO3 (TOTAL = 80 L)

SAMPLE	TIME (h-min)	CURRENT DENSITY (A/sq.m)	FARADAY PASSED (F)	VOLTAGE (V)					TEMP. CELSIUS	VOLUME (l)	SAMPLE ANALYSIS													
				OVERALL	CELL	MEMBRANE	C-M	A-M			pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	OH- (g/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	Na+ (g/l)	Ca++ (mg/l)	Mg++ (mg/l)	COD (g/l)	TS (g/l)
ANOLYTE	0,00	60	0,0	4,4					23	40,0	9,2	76				0,0	31,7	42,5	54,2	41,3	18	4		
CATHOLYTE		500		6,5						30,0		18				26,4	18,0	0,0	13,1	47,2				
ABS.COL.		900		8,1						40,0	9,0	78				0,0	49,2	86,6	99,1	43,1	19	4		
		1200		9,2																				
		1500		10,2																				
		2000		11,9																				
	0,10	2000		12,1	TURNED CURRENT DOWN																			
		1400		10,7																				
	2,35	1400	6,3	8,7					47															
	7,25	1400	16,3	9,1					55	TURNED CURRENT DOWN														
		1200		8,2																				
ANOLYTE	8,10	1200	20,1						56	31,6	7,9	62				0,0	26,9	17,3	32,3	28,2				
CATHOLYTE										34,0						26,4	18,0	0,0	13,1	58,1				
ABS.COL.										40,0	8,9	70				0,0	26,9	102,2	94,2					
AT THIS STAGE THE LIQUOR IN THE ABSORPTION COLUMN WAS REMOVED AND 40 L SCOUR EFFLUENT (CONTAINING 167G/L NAHCO3) WAS ADDED. THE CURRENT WAS TURNED DOWN.																								
		1000		7,6																				
ANOLYTE	11,35	1000	26,4	7,8					48	31,7	8,3	59				0,0	21,6	23,9	33,2	25,4	6	5		
CATHOLYTE										31,8						35,7	12,0	0,0	8,8	65,1				
ABS.COL.										40 + 40	9,2	75				0,0	37,1	65,4	71,9					
AT THIS STAGE THE CELL WAS SWITCHED OFF OVER NIGHT.																								
	11,35	1400	26,4	10,3					24															
ANOLYTE	16,40	1400	39,3	8,3					47	27,3	9,4	64				0,0	28,6	17,6	33,7	25,1	5	4		
CATHOLYTE										25,0						39,1	18,0	0,0	13,1	72,8				
ABS.COL.										40 + 40	9,2	78				0,0	31,2	70,5	74,2					
ANOLYTE	19,10	1400	45,7	8,0					48	26,4	9,4	59				0,0	27,8	20,5	31,6	26,6	4	3		
CATHOLYTE										24		31				48,5	15	0	11	78,4				
ABS.COL.										40 + 40	9	7,8				0	34,8	61	69,9		73	6		

NOTE: 1) THE LEVEL OF CATHOLYTE DECREASED DURING EXPERIMENTATION DUE TO A LEAK IN THE PIPEWORK.
2) FLOW AND MANIFOLD CONFIGURATIONS AS IN EXP. 17 CARBONATION

AS TABLE 99

EXPERIMENT NO 18: ELECTROLYSIS OF EFFLUENT SAMPLE B

ANOLYTE : 43 L FROM EXP 18 NF
CATHOLYTE : 20 L NAOH
ABSORBTION COL : 40 L FROM EXP 18A + 20 L RAW SCOUR EFFLUENT CONTAINING 150G/L NAHCO3 (TOTAL : 120 L)

SAMPLE	TIME (h-min)	CURRENT DENSITY (A/sq.m)	FARADAY PASSED (F)	VOLTAGE (V) OVERALL	CELL	MEMBRANE	C-M	A-M	TEMP. CELSIUS	VOLUME (l)	SAMPLE ANALYSIS pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	OH- (g/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	Na+ (g/l)	Ca++ (mg/l)	Mg++ (mg/l)	COD (g/l)	TS (g/l)
ANOLYTE	0,00	60	0,0	4,3					19	43,0	9,5	81				0,0	36,7	44,9	59,6					
CATHOLYTE		600		7,4						20,0		28				40,0	15,0	0,0	11,0					
ABS.COL.		1000		9,5						60,0	9,1	78				0,0	31,7	77,3	79,9					
		1500		10,5																				
		1800		11,8																				
	1,05	1400	2,1	10,3					32															
	2,00	400	4,3	6,2	3,1				41															
					3,0																			
		800		7,5	3,7																			
					3,6															25,4	7	5		
		1200		8,9	4,3																			
					4,2															87,7				
		1400		9,4	4,7	0,15																		
					4,2	0,07														42,0	39	5		
		1600		10,3	4,9																			
					4,8																			
		2000		11,6	5,5																			
					5,0																			
		2600		12,8	6,2																			
					5,8																			
		3200		14,3	6,7																			
					6,6																			
		4000		16,3	7,4															38,4				
					7,8																			
		4300		17,1	7,6	CONTINUED TO RUN CELL AT 1400 A/M2																		
					8,3																			
	3,50	400	9,6	6,0	3,0																			
					2,9				49															
		1200		8,7	4,3																			
					4,1																			
		1400		9,1	4,1	0,18																		
					4,3	0,03																		
		2000		11,0	4,8																			
					5,0																			
		2600		11,7	5,2																			
					5,9																			
		3200		13,7	5,9																			
					6,9																			
		4000		16,6	7,0															18,1	7	5		
					8,6																			
		5560		25,4	9,3	CONTINUED TO RUN CELL AT 1400 A/M2														79,3				
					13,9																			

SAMPLE	TIME (h-min)	CURRENT DENSITY (A/sq.m)	FARADAY PASSED (F)	VOLTAGE (V) OVERALL	CELL	MEMBRANE	C-M	A-M	TEMP. CELSIUS	VOLUME (l)	SAMPLE ANALYSIS pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	OH- (g/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	Na+ (g/l)	Ca++ (mg/l)	Mg++ (mg/l)	COD (g/l)	TS (g/l)
ANOLYTE	5,40	200	14,2	5,4	2,8				49	36	8,4	73				0,0	30,7	36,1	48,8	46,5				
					2,7																			
CATHOLYTE		600		7,0	3,5					23,6						43,4	21,0	0,0	15,3					
					3,4																			
ABS.COL.		1200		8,9	4,4					60	9,2	78				0,0	40,8	54,9	67,9					
					4,3																			
		1400		9,5	4,7	0,20																		
					4,5	0,01																		
		2000		11,6	5,5																			
					5,1																			
		3000		14,9	6,9																			
					7,2																			
		3400		16,8	7,7	CONTINUED TO RUN CELL AT 1400 A/M2																		
					8,1																			
	7,42	200	20,3	5,5	2,7				46															
					2,8																			
		600		7,0	3,6																			
					3,5																			
		1200		9,3	4,5																			
					4,5																			
		1400		10,0	4,3																			
					4,8																			
		1800		11,4	5,5																			
					5,4																			
		2600		15,1	6,7																			
					7,7																			
		3200		17,3	7,8	CONTINUED TO RUN CELL AT 1700 A/M2																		
					8,5															8,7	4	5		
	9,20	200	25,4	5,7	2,8																			
					2,8															75,0				
		1000		8,8	4,3															45,6	69	5		
					4,3															48,1	14	5		
		1700		11,1	4,7															70,2				
					5,9															41,3	45	5		
		2400		14,2	5,7																			
					7,7																			
		2900		16,6	6,6																			
					9,2																			
		3000		17,2	6,9	CONTINUED TO RUN CELL AT 1700 A/M2																		
					9,9																			
ANOLYTE	10,50	200	30,6	5,5	2,7				53	30,1	8,1	56				0,0	17,3	35,6	38,6					
					2,8																			
CATHOLYTE		700		7,4	3,3					26,7		30				49,3	21,0	0,0	15,3					
					3,8																			
ABS.COL.		1500		10,8	4,4					60	8,8	72				0,0	22,8	37,8	64,1					
					5,8																			
		1300		12,0	4,7																			
					6,7																			
		2000		13,3	5,1																			
					7,9																			
		2600		17,5	6,1																			
					12,8																			

(ii)

SAMPLE	TIME (h-min)	CURRENT DENSITY (A/sq.m)	FARADAY PASSED (F)	VOLTAGE (V) OVERALL	CELL	MEMBRANE	C-M	A-M	TEMP. CELSIUS	VOLUME (l)	SAMPLE ANALYSIS pH	COND (mS/cm)	IC (g/l)	TC (g/l)	OC (g/l)	OH- (g/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	Na+ (g/l)	Ca++ (mg/l)	Mg++ (mg/l)	COD (g/l)	TS (g/l)
THE EXPERIMENT WAS STOPPED OVERNIGHT. THE EFFLUENT IN THE ABSORPTION COLUMN WAS REPLACED WITH 60 L SCOUR EFFLUENT CONTAINING 125G/L NAHCO3: OF THE FOLLOWING COMPOSITION:											9,7	73				0,0	49,0	22,4	52,1					
THE ANOLYTE VOLUME WAS DOWN TO 18L DUE TO A LEAK IN THE VALVE ON THE ANOLYTE TANK																								
	10,50	60	30,6	4,1					20	THE ANOLYTE VOLUME WAS DOWN TO 18 L DUE TO A LEAK IN THE VALVE ON THE ANOLYTE TANK.														
		500		7,7																				
		000		9,9																				
		1200		12,9																				
		1400		14,5	6,1	0,26	1,7	4,4																
					8,5	0,34	1,7	6,3																
	11,00	1400	30,9	16,3	TURNED CURRENT DOWN																			
		1200		14,8	6,9	0,18	1,9	4,8																
					7,7	0,16	1,8	4,8																
ANOLYTE	12,45	200	34,7	6,1					39	14,5	8,5	48				0,0	18,2	9,5	20,1					
CATHOLYTE		600		8,6						29,5						44,2	24,0	0,0	17,5					
ABS.COL.		1000		11,5						60 + 60	9,3	79				0,0	40,3	60,6	73,7	38,3				
		1200		13,3	3,0	0,14	1,4	4,1																
					7,1	0,10	0,9	4,7												80,2				
		1600		15,4	6,1															47,7				
					8,2																			
		2000		18,2	6,6																			
					11,1																			
		2200		9,4	7,2	CONTINUED TO RUN CELL AT 1200 A/M2																		
					12,1																			
	14,35	200	38,4	6,9	3,2				42															
					3,6																			
		400		8,7	3,9																			
					4,7																			
		900		13,1	5,7																			
					7,2																			
		1000		13,8	5,1	0,10	1,3	3,7																
					8,5	0,09	1	6,8																
		1500		18,6	7,8																			
					10,3																			
		1900		22,9	9,4																			
					13,1																			
		2000		24,5	8,2	CONTINUED TO RUN CELL AT 1000 A/M2																		
					14,1																			
	14,55	1000	39,7	15,3		TURNED CURRENT DOWN																		
		800		13,1																				
ANOLYTE	15,35	000	40,6	15,0	5,9				40	5,4	7,9	72				0,0	50,4	14,2	47,2					
					9,0																			
CATHOLYTE										34,8		26				41,7	27,0	0,0	19,7					
ABS.COL.										60 + 60	9,2	79				0,0	42,7	54,7	71,1					

AS TABLE 90

EXPERIMENT 19:MICROFILTRATION

FEED:90 L CARBONATED EFFLUENT FROM EXP18A AND 18B

TIME	SAMPLE	VOL	PERM.	FLUX	SAMPLE ANALYSIS													POINT REJECTION (%)									
			RECOVERY		pH	COND	TC	IC	OC	COD	Na	Ca	Mg	CO3=	HCO3-	TOT. CO2	TS	COND	TC	IC	OC	COD	Na	Ca	Mg	TOT. CO2	TS
(h-min)		(l)	(%)	(l/m2/h)		(mS/cm)	(g/l)	(g/l)	(g/l)	(g/l)	(g/l)	(mg/l)	(mg/l)	(g/l)	(g/l)	(g/l)	(g/l)										
0.00	FEED	90			8.8	76					42.2	35.0	6.0	28.1	71.5	72.7	96.4										
	PERM	0	0	2	9.1	81					44.0	9.0	4.0	37.2	57.3	69.0	103.3	0					0	74	33	5	0
				@ 200kPa																							
12.00	FEED			@ 35C	9.5	91					67.4	19.0	7.0	81.1	63.2	105.3	160.8										
	PERM	60	34		9.4	91					58.6	15.0	7.0	59.0	54.2	82.6	134.6	0					13	12	0	22	17

AT THIS STAGE ONE OF THE HOSES ON THE CFMF RIG BURST AND THE REMAINING FEED WAS LOST.

AS TABLE 91

EXPERIMENT 19: NANOFILTRATION

FEED: 60 L FROM EXPERIMENT 19 CROSS-FLOW MICROFILTRATION

TIME (h-min)	SAMPLE	VOL (l)	PERM. RECOVERY (%)	FLUX (l/m2/h)	SAMPLE ANALYSIS pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	COD (g/l)	Na (g/l)	Ca (mg/l)	Mg (mg/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	TS (g/l)
0.00	FEED	33			9.4	81					43.7	7.0	7.0	43.4	33.7	56.3	101.7
	PERM	0	0	71.4	9.4	78					38.6	4.0	4.0	40.9	49.8	65.6	93.8
				@ 0.6MP @ 20C													
AT THIS STAGE THE MEMBRANE WAS RUN ON REACTIVEDYE . COLOUR REJECTION WAS NOT COMPLETE. THE ORIGINAL NF MEMBRANE WAS INSTALLED IN PLACE OF THE SMITH & NEPHEW MEMBRANE. RESTARTED																	
0.00	PERM	30	50	3.5													
				@ 24C													
7.15	FEED				9.6	98					73.4	28.0	10.0	90.0	57.1	107.4	190.1
	PERM	43	72	1.8	9.5	96					62.9	4.0	3.0	72.0	58.6	95.3	150.6
				@ 58C													

TIME (h-min)	SAMPLE	POINT REJECTION (%) COND	TC	IC	OC	COD	Na	Ca	Mg	TOT. CO2	TS
0.00	FEED										
	PERM	4					12	43	43	0	8
0.00	PERM										
7.15	FEED										
	PERM	0					14.0	86.0	70.0	11.0	21.0

COMMENTS:

COMPANY:

EXPERIMENT NO 19A : ELECTROLYSIS OF EFFLUENT SAMPLE A

ANOLYTE : 30 L FROM EXP 19 NF
CATHOLYTE : 20 L NAOH
ABSORBTION COL : 60 L SCOUR EFFLUENT (CONTAINING 125G/L NAHCO3) FROM EXP 18B.

SAMPLE	TIME	CURRENT DENSITY	FARADAY PASSED	VOLTAGE (V)					TEMP. CELSIUS	VOLUME	SAMPLE ANALYSIS													
	(h-min)	(A/sq.m)	(F)	OVERALL	CELL	MEMBRANE	C-M	A-M		(l)	pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	OH- (g/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	Na+ (g/l)	Ca++ (mg/l)	Mg++ (mg/l)	COD (g/l)	TS (g/l)
ANOLYTE	0,00	60	0,0	4,9					23	30,0	9,5	64				0,0	35,5	37,2	52,5	38,6	15	3		
CATHOLYTE		200		6,3						20,0						23,8	6,0	0,0	44,0	58,6				
ABS.COL.		600		10,5						60,0	9,1	80				0,0	37,4	70,5	78,8	45,0	70	50		
		1200		13,8																				
	0,50	1000	0,1	13,7	5,2	0,18	1,9	3,1																
					7,0	0,23	2,5	4,2																
	1,15	200	3,1	5,9	2,8				40															
					3,0																			
		600		8,1	3,6																			
					4,5																			
		900		10	4,1																			
					6,0																			
		1400		13,9	5,1	0,16	1,5	3,2																
					8,0	0,20	1,5	5,5																
		1800		17,4	5,7																			
					10,7																			
		2000		17,9	5,8																			
					11,2																			
		2200		18,7	5,7	CONTINUED TO RUN CELL AT 1400 A/M2 (13,9 VOLTS)																		
					12,0																			
	3,25	200	7,7	5,8	2,7				51															
					3,1																			
		600		8,1	3,5																			
					4,5																			
		900		10	4,0																			
					6,0																			
		1500		14,8	4,9																			
					9,5																			
		2000		18,2	4,8																			
					12,7																			
		2100		19,3	5	CONTINUED TO RUN CELL AT 1400 A/M2 (14,1V)																		
					13,8																			
ANOLYTE	4,50	1400	11,3	15,1	4,7				54	23,7	8,8	68				0	19,2	49,4	50,1	30,8	11,3	4		
					10																			
CATHOLYTE	TURNED CURRENT DOWN									21,1						30,6	24	0	17,5	61,6				
ABS.COL.		1200		13,3	4,4					60	9,2	82				0	41,3	69,8	81,1					
-					8,8																			
	5,20	STOPPED EXPERIMENT DUE TO BAD LEAK IN CATHOLYTE PIPING (1.8L/MIN). AMP-HOUR AND AMP-METER MALFUNCTIONING. RESTARTED EXPERIMENT AFTER 3 DAYS.																						

AS TABLE 12 C/1 (1)

SAMPLE	TIME (h-min)	CURRENT DENSITY (A/sq.m)	FARADAY PASSED (F)	VOLTAGE (V) OVERALL	CELL	MEMBRANE	C-M	A-M	TEMP. CELSIUS	VOLUME (l)
	5,20	100	12,5	4,8					30	
		200		6,7						
		600		12,4						
		800		15,4						
	5,25	600		13,4	4,3	0,1				
					9,1	0,01				
	7,35	300	14,9	7	2,2					
					4					
		600		12,2	3,8	0,14				
					7,2	0,1				
		800		15,9	4,5					
					9,9					
		1200		19,2	5,1					
					14					
		1500		23,2	5,6					
					17					
		1700		25,3	6	CONTINUED TO RUN CELL AT 600A/M2				
					18,7					
	10,00	200	17,6	7,1	2,9				54	
					4,2					
		600		11,8	3,8					
					7,8					
		800		13,6	4,1					
					9,6					
		1000		16,2	4,5					
					11,6					
		1200		18,8	4,8					
					13,6					
		1400		21,4	5,1					
					15,8					
		1700		24,9	5,6	CONTINUED TO RUN CELL AT 600A/M2				
					18,6					
ANOLYTE	12,15	200	20,1	7,1	2,9				57	17,7
					4,2					
CATHOLYTE		400		9,4	3,3					25,7
					6					
ABS.COL.		600		12	3,7	0,1	1,2	2,3		60
					8	0,02	0,2	6		
		800		14,4	4,1					
					10,1					
		1200		19,1	4,8		-			
					15,9					
		1400		21,6	5,1					
					16					
		1600		24,4	5,4					
					18,4					
STOPPED EXPERIMENT OVERNIGHT										
	12,25	60	20,5	4,8					25	
		200		8,6						
		300		12,3	4	0,2	1,5	2,8		
					8,2	0,2	1,8	5,7		
		500		14,8						
		800		21,4						
		900		24,1		CONTINUED TO RUN CELL AT 300A/M2				

SAMPLE	SAMPLE ANALYSIS pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	OH- (g/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	Na+ (g/l)	Ca++ (mg/l)	Mg++ (mg/l)	COD (g/l)	TS (g/l)
ANOLYTE	8,1	67				0	7,8	70,5	57,2	33,3	7	4		
CATHOLYTE						20,4	24	0	17,5	48,6				
ABS.COL.	9,1	81				0	32,4	62,2	69,1					

A5 TABLE 92 (cont.)
(ii)

SAMPLE	TIME (h-min)	CURRENT DENSITY (A/sq.m)	FARADAY PASSED (F)	VOLTAGE (V) OVERALL	CELL	MEMBRANE	C-M	A-M	TEMP. CELSIUS	VOLUME (l)	SAMPLE ANALYSIS pH	COND (mS/cm)	TC (g/l)	IC (g/l)	OC (g/l)	OH- (g/l)	CO3= (g/l)	HCO3- (g/l)	TOT. CO2 (g/l)	Na+ (g/l)	Ca++ (mg/l)	Mg++ (mg/l)	COD (g/l)	TS (g/l)
	14,05	200	21,5	8,6	3,3				30															
					5,2																			
		300		10,9																				
		400		12,1	3,8																			
					8,2																			
		500		14,4	4,1																			
					10,3																			
		800		19,6	4,8																			
					14,7																			
		1000		23,8	5,3	CONTINUED TO RUN CELL AT 400A/M2 (12,4V)																		
					18,1																			
	15,10	400	22,3	11,9					45	TURNED CURRENT UP														
		500		13,6	3,9	0,5	1,4	2,8																
					9,5	0,2	2	7,6																
	15,50	200	23	8,2	3,1				48															
					5																			
		500		12,8	3,8																			
					9																			
		600		14,4	4	0,3	1,4	3																
					10,2	0,2	2	8,2																
		800		17,6	4,4																			
					13																			
		1000		21,2	4,9																			
					16,1																			
		1200		24,7	5,3	CONTINUED TO RUN CELL AT 600A/M2																		
					19																			
	19,00	600	26,4	15	4				58	TURNED CURRENT DOWN														
					10,7																			
		400		11,3	3,5																			
					7,6																			
	19,55	200	27,1	6,2	3																			
					5,1																			
		400		12,1	3,6																			
					8,2																			
		500		13	3,8																			
					9,4																			
		800		18,6	4,6																			
					14,1																			
		1000		22,3	4,9																			
					16,9																			
		1200		25,4	5,2	CONTINUED TO RUN CELL AT 400A/M2																		
					19,7																			
ANOLYTE	23,10	400	29,6	13	3,5				54	5,8	8,2	46				0	5,2	37,7	31,3	19,3	6	4		
					8,4																			
CATHOLYTE										35,8						17	24	0	17,5	44,6				
ABS.COL.										60	8,9	75				0	30	80	80,3					

A7 TABLE 1

EXPERIMENT NO 1 : CARBONATION

ANOLYTE: 20L AT 75G/L NA2CO3

SAMPLE	FARADAYS	THEORETICAL CHANGE (MOL)	VOLUME (l)	Na SPECIES TOTAL Na (G)	Na SPECIES OBS CHANGE (MOL)	Na SPECIES C.EFF. (%)	CO3= / HCO3- SPECIES TOTAL CO3 (G)	CO3= / HCO3- SPECIES TOTAL CO2 (G)	CO3= / HCO3- SPECIES OBS CHANGE (MOL CO3)	CO3= / HCO3- SPECIES OBS CHANGE (MOL CO2)	CO3= / HCO3- SPECIES TOT CHANGE (CO3+CO2)	CO3= / HCO3- SPECIES C EFF. (%)	OH- SPECIES TOTAL OH (G)	OH- SPECIES OBS CHANGE (MOL)	OH- SPECIES C. EFF. (%)	CATH CONC (G/L Na)	ANOL CONC (G/L Na)
ANOLYTE	0,0	0,0	20,0	620			772	566									31,0
CATHOLYTE			15,0	720				53					477			48,0	
ABS.COL.			35,0					63									
ANOLYTE	4,0	8,0	19,4	462	6,9	86	382	584	6,5	0,0	6,5	81					23,8
CATHOLYTE			15,9	922	8,8	100		81		0,6			609	7,8	97	58,0	
ABS.COL.			35,0					32		0,0	0,0	0					
ANOLYTE	9,6	19,2	18,2	257	15,8	82	0	479	12,9	2,0	14,9	78					14,1
CATHOLYTE			16,8	1107	16,8	88		94		0,9			704	13,4	70	65,9	
ABS.COL.			35,0					102		0,9	0,9	5					
ANOLYTE	12,6	25,2	17,6	148	20,5	81	114	199	11,0	8,3	19,3	77					8,4
CATHOLYTE			17,4	1183	20,1	80		64		0,3			847	21,8	86	68,0	
ABS.COL.			35,0					161		2,2	2,2	9					
ANOLYTE	15,7	31,4	16,5	33	25,5	81	0	66	12,9	11,4	24,3	77					2,0
CATHOLYTE			17,4	1288	24,7	79		113		2,6			868	23,0	73	74,0	
ABS.COL.			35 + 32					161+163		4,5	4,5	14					

NOTE: % OF TOTAL ANOLYTE CO3 TRANSFERRED TO CATHOLYTE : 20%

COMMENTS:

DATE:

A7 TABLE 2

EXPERIMENT NO 1 : ELECTROLYSIS OF EFFLUENT SAMPLE A

ANOLYTE: 25L PERM FROM EXP 1 NF

SAMPLE	FARADAYS	THEORETICAL CHANGE (MOL)	VOLUME (l)	Na SPECIES			CO3= / HCO3- SPECIES						OH- SPECIES			CATH CONC	ANOL CONC
				TOTAL Na (G)	OBS CHANGE (MOL)	C.EFF. (%)	TOTAL CO3 (G)	TOTAL CO2 (G)	OBS CHANGE (MOL CO3)	OBS CHANGE (MOL CO2)	TOT CHANGE (CO3+CO2)	C EFF. (%)	TOTAL OH (G)	OBS CHANGE (MOL)	C. EFF. (%)	(G/L Na)	(G/L Na)
ANOLYTE	0,0	0,0	25,0	45			5	75									1,3
CATHOLYTE			16,0	1085				69					1035			67,8	
ABS.COL.			25,0					30									
ANOLYTE	0,6	1,2	24,7	25	0,9	72	0	47	0,1	0,6	0,7	58					1,0
CATHOLYTE			16,1	1032	0,0	0		64		0,0			1028	0,0	0	64,1	
ABS.COL.			25,0					43		0,3	0,3	25					
ANOLYTE	1,0	2,0	24,6	7	1,7	83	0	10	0,1	1,5	1,6	80					0,3
CATHOLYTE			16,3	1060	0,0	0		64		0,0			857	0,0	0	65,0	
ABS.COL.			25,0					58		0,6	0,6	32					

COMMENTS:

DATE:

A7 TABLE 3

EXPERIMENT NO 1 : ELECTROLYSIS OF EFFLUENT SAMPLE B

ANOLYTE: 32L OF EXP 1 NF PERM

SAMPLE	FARADAYS	THEORETICAL CHANGE (MOL)	VOLUME (l)	Na SPECIES TOTAL Na (G)	Na SPECIES OBS CHANGE (MOL)	Na SPECIES C.EFF. (%)	CO3= / HCO3- SPECIES TOTAL CO3 (G)	CO3= / HCO3- SPECIES TOTAL CO2 (G)	CO3= / HCO3- SPECIES OBS CHANGE (MOL CO3)	CO3= / HCO3- SPECIES OBS CHANGE (MOL CO2)	CO3= / HCO3- SPECIES TOT CHANGE (CO3+CO2)	CO3= / HCO3- SPECIES C EFF. (%)	OH- SPECIES TOTAL OH (G)	OH- SPECIES OBS CHANGE (MOL)	OH- SPECIES C. EFF. (%)	CATH CONC (G/L Na)	ANOL CONC (G/L Na)
ANOLYTE	0,0	0,0	32,0	58			13	102									1,8
CATHOLYTE			16,0	1120				85					814			70,0	
ABS.COL.			25,0					53									
ANOLYTE	0,9	1,8	31,9	35	1,0	56	0	64	0,2	0,9	1,1	61					1,1
CATHOLYTE			16,3	1138	0,8	43							867	3,1	100	69,8	
ABS.COL.			25,0					58		0,1	0,1	6					
ANOLYTE	1,3	2,6	31,9	13	2,0	75	0	16	0,2	1,4	1,6	63					0,4
CATHOLYTE			16,3	1092	0,0	0		57		0,0			918	6,1	100	67,0	
ABS.COL.			25,0					90		0,8	0,8	32					

COMMENTS:

DATE:

A7 TABLE 4

EXPERIMENT NO 2 : CARBONATION

ANOLYTE: 50L AT 75G/L NA2CO2

SAMPLE	FARADAYS	THEORETICAL CHANGE (MOL)	VOLUME (l)	Na SPECIES: TOTAL Na (G)	Na SPECIES: OBS CHANGE (MOL)	Na SPECIES: C.EFF. (%)	CO3= / HCO3- SPECIES: TOTAL CO3 (G)	TOTAL CO2 (G)	OBS CHANGE (MOL CO3)	OBS CHANGE (MOL CO2)	TOT CHANGE (CO3+CO2)	C EFF. (%)	OH- SPECIES: TOTAL OH (G)	OBS CHANGE (MOL)	C. EFF. (%)	CATH CONC (G/L Na)	ANOL CONC (G/L Na)
ANOLYTE	0,0	0,0	50,0	2250			2645	1980									45,0
CATHOLYTE			15,0	464				83					329			30,9	
ABS.COL.			40,0					92									
ANOLYTE	2,8	5,6	49,4	1946	13,2	100	3018	2174				0					39,4
CATHOLYTE			15,4	505	1,8	32		22		0,0			351	1,3	23	32,8	
ABS.COL.			40,0					56				0					
ANOLYTE	10,1	20,2	48,1	1597	28,4	100	1693	1890	15,9	2,0	17,9	89					33,0
CATHOLYTE			16,5	673	9,1	45		28					515	10,9	54	40,8	
ABS.COL.			49,0														
ANOLYTE	18,0	36,0	47,2	1369	38,3	100	1001	1878	27,4	2,3	29,7	83					29,0
CATHOLYTE			17,7	924	20,0	56		16					628	17,6	49	52,2	
ABS.COL.			40,0														
ANOLYTE	29,1	58,2	44,9	858	60,5	100	144	1621	41,7	8,2	49,9	86					19,1
CATHOLYTE			19,7	1221	33,0	57		59					814	28,5	49	62,0	
ABS.COL.			40,0					284		4,4	4,4	8					
ANOLYTE	35,4	70,8	43,3	771	64,0	90	381	1018	37,7	21,9	59,6	84					17,8
CATHOLYTE			20,5	1328	38,0	53		43					904	33,8	48	64,8	
ABS.COL.			40,0					440		7,9	7,9	11					

SAMPLE	FARADAYS	THEORETICAL CHANGE (MOL)	VOLUME (l)	Na SPECIES			$CO_3^{=}$ / HCO_3^{-} SPECIES						OH^{-} SPECIES			CATH CONC (G/L Na)	ANOL CONC (G/L Na)
				TOTAL Na (G)	OBS CHANGE (MOL)	C.EFF. (%)	TOTAL CO_3 (G)	TOTAL CO_2 (G)	OBS CHANGE (MOL CO_3)	OBS CHANGE (MOL CO_2)	TOT CHANGE (CO_3+CO_2)	C EFF. (%)	TOTAL OH (G)	OBS CHANGE (MOL)	C. EFF. (%)		
ANOLYTE	39,4	78,8	42,8	556	73,7	93	407	719	37,3	28,7	66,0	84					13,0
CATHOLYTE			21,0	1586	48,8	62		40					1046	42,2	54	75,5	
ABS.COL.			40,0					760		15,2	15,2	19					
ANOLYTE	40,7	81,4	42,6	571	73	90	175	728	41,2	28,5	69,7	86					13,4
CATHOLYTE			21,4	1466	43,6	54										68,5	
ABS.COL.			40 + 35					760+165		28.5+1.9	30,4	37					
ANOLYTE	43,5	87	41,5	415	79,8	92	116	623	42,2	30,8	73	84					10
CATHOLYTE			21,7	1445	42,7	49							1048	42,2	49	66,6	
ABS.COL.			40 + 35					760+308		28.5+5.2	33,7	39					
ANOLYTE	51,4	102,8	39,9	104	93,3	91	32	184	43,6	40,8	84,4	82					2,6
CATHOLYTE			22,7	1525	46,1	45		50		0,2			1140	47,7	46	67,2	
ABS.COL.			40 + 35					760+634		28.5+12.6	41,1	40					

NOTE: TOTAL CO_2 CONCENTRATION IN 2ND 35L OF ABS COL EFFLUENT TAKEN AS 2.3G/L

A7 TABLE 5

EXPERIMENT NO: 2 ELECTROLYSIS OF EFFLUENT SAMPLE A

ANOLYTE: 20L FROM EXP 2 NF

SAMPLE	FARADAYS	THEORETICAL CHANGE (MOL)	VOLUME (l)	Na SPECIES TOTAL Na (G)	OBS CHANGE (MOL)	C.EFF. (%)	CO3= / HCO3- SPECIES TOTAL CO3 (G)	TOTAL CO2 (G)	OBS CHANGE (MOL CO3)	OBS CHANGE (MOL CO2)	TOT CHANGE (CO3+CO2)	C EFF. (%)	OH- SPECIES TOTAL OH (G)	OBS CHANGE (MOL)	C. EFF. (%)	CATH CONC (G/L Na)	ANOL CONC (G/L Na)
ANOLYTE	0,0	0,0	20,0	120			76	176									6,0
CATHOLYTE			15,0	740				39					498			49,3	
ABS.COL.			25,0					45									
ANOLYTE	1,7	3,4	17,2	79	1,8	52	50	124	4,3	1,2	5,5	100					4,6
CATHOLYTE			15,6	831	5,4	100							543	2,6	78	53,3	
ABS.COL.			25,0					93		1,1	1,1	32					
ANOLYTE	3,5	7,0	16,5	17	4,5	64	3	18	1,7	3,6	5,3	76					1,0
CATHOLYTE			15,9	882	6,2	88							603	6,2	88	55,5	
ABS.COL.			25,0					195		3,4	3,4	49					
ANOLYTE	3,8	7,6	16,3	8	4,9	64	0	10	1,8	3,7	5,5	72					0,5
CATHOLYTE			16,1	942	8,8	100		31								58,5	
ABS.COL.			25,0					218		3,9	3,9	52					

COMMENTS: DURING THIS EXPERIMENT THE GAS LINE CONNECTING THE ANOLYTE TANK TO THE ABSORPTION COLUMN WAS TWISTED AND THE PASSAGE OF GAS MAY HAVE BEEN INHIBITED

A7 TABLE 6

EXPERIMENT NO 2: ELECTROLYSIS OF EFFLUENT SAMPLE B

ANOLYTE: 20L FROM EXP 2 NF

SAMPLE	FARADAYS	THEORETICAL CHANGE (MOL)	VOLUME (l)	Na SPECIES			CO3= / HCO3- SPECIES						OH- SPECIES			CATH CONC (G/L Na)	ANOL CONC (G/L Na)
				TOTAL Na (G)	OBS CHANGE (MOL)	C.EFF. (%)	TOTAL CO3 (G)	TOTAL CO2 (G)	OBS CHANGE (MOL CO3)	OBS CHANGE (MOL CO2)	TOT CHANGE (CO3+CO2)	C EFF. (%)	TOTAL OH (G)	OBS CHANGE (MOL)	C. EFF. (%)		
ANOLYTE	0,0	0,0	20,0	114			40	166									5,7
CATHOLYTE			16,0	850				29					517			53,1	
ABS.COL.			30,0					219									
ANOLYTE	1,4	2,8	18,5	91	1,0	35	24	144	0,3	0,5	0,8	29					4,9
CATHOLYTE			16,5	923	3,2	100							573	3,3	100	56,1	
ABS.COL.			30,0					228		0,2	0,2	7					
ANOLYTE	3,0	6,0	18,5	13	4,4	73	0	31	0,7	3,1	3,8	63					0,7
CATHOLYTE			16,9	985	5,9	98		4					634	6,8	100	58,3	
ABS.COL.			30,0					231		0,3	0,3	5					

COMMENTS:

DATE:

A7 TABLE 7

EXPERIMENT NO 3 : CARBONATION

ANOLYTE: 50L AT 100G/L NA2CO3

SAMPLE	FARADAYS	THEORETICAL CHANGE (MOL)	VOLUME (l)	Na SPECIES: TOTAL Na (G)	Na SPECIES: OBS CHANGE (MOL)	Na SPECIES: C.EFF. (%)	CO3= / HCO3- SPECIES: TOTAL CO3 (G)	CO3= / HCO3- SPECIES: TOTAL CO2 (G)	CO3= / HCO3- SPECIES: OBS CHANGE (MOL CO3)	CO3= / HCO3- SPECIES: OBS CHANGE (MOL CO2)	CO3= / HCO3- SPECIES: TOT CHANGE (CO3+CO2)	CO3= / HCO3- SPECIES: C EFF. (%)	OH- SPECIES: TOTAL OH (G)	OH- SPECIES: OBS CHANGE (MOL)	OH- SPECIES: C. EFF. (%)	CATH CONC (G/L Na)	ANOL CONC (G/L Na)
ANOLYTE	0,0	0,0	50,0	2250			2350	1725									45,0
CATHOLYTE			15,0	734				14					471			48,9	
ABS.COL.			40,0					228									
ANOLYTE	11,2	22,4	48,3	1835	18,0	81	1704	2058	10,8	0,0	10,8	48					38,0
CATHOLYTE			16,3	1108	16,3	73							828	21,0	94	68,0	
ABS.COL.			40,0														
ANOLYTE	38,5	77,0	42,9	686	68,0	88	56	1278	38,2	7,5	45,7	59					16,0
CATHOLYTE			20,1	2227	64,9	84							1893	83,6	100	110,8	
ABS.COL.			40,0					880		14,8	14,8	19					
ANOLYTE	50,1	100,2	40,5	239	87,4	87	0	393	39,2	30,3	69,5	70					5,9
CATHOLYTE			21,7	2995	98,3	98		95		1,9			1751	75,3	75	138,0	
ABS.COL.			40 + 35					880+543		14.8+10.5	25,3	25					

COMMENTS:NOTE 1: TOTAL CO2 CONCENTRATION IN 2ND 35L TO ABS COLUMN TAKEN AS 2.3G/L
2: % OF TOTAL ANOLYTE CO2 TRANSFERRED TO CATHOLYTE = 5

DATE:

A7 TABLE 8

EXPERIMENT NO 3 : ELECTROLYSIS OF EFFLUENT SAMPLE A

ANOLYTE: 25L NF PERM FROM EXP 3 NF

SAMPLE	FARADAYS	THEORETICAL CHANGE (MOL)	VOLUME (l)	Na SPECIES			CO3= / HCO3- SPECIES						OH- SPECIES			CATH CONC	ANOL CONC
				TOTAL Na (G)	OBS CHANGE (MOL)	C.EFF. (%)	TOTAL CO3 (G)	TOTAL CO2 (G)	OBS CHANGE (MOL CO3)	OBS CHANGE (MOL CO2)	TOT CHANGE (CO3+CO2)	C EFF. (%)	TOTAL OH (G)	OBS CHANGE (MOL)	C. EFF. (%)	(G/L Na)	(G/L Na)
ANOLYTE	0,0	0,0	25,0	310			195	400									12,4
CATHOLYTE			15,0	1046				24					789			69,7	
ABS.COL.			25,0					48									
ANOLYTE	2,3	4,6	24,7	190	5,2	100	109	249	1,4	3,4	4,8	100					7,7
CATHOLYTE			15,1	1095	2,1	46							670		0	72,5	
ABS.COL.			25,0					75	0,0	0,6	0,6	13					
ANOLYTE	6,8	13,6	23,6	66	10,6	78	12	101	3,1	6,8	9,9	73					2,8
CATHOLYTE			15,4	1197	6,6	48							958	9,9	73	77,7	
ABS.COL.			25,0					248	0,0	4,5	4,5	33					
ANOLYTE	7,2	14,4	23,4	14	12,9	89	0	9	3,3	8,9	12,2	85					0,6
CATHOLYTE			17,5	1363	13,8	96		47		0,5			926	8,1			
ABS.COL.			25,0					318	6,1	6,1	43,0						

COMMENTS:NOTE : % OF TOTAL ANOLYYTE CO3 TRANSFERRED TO CATHOLYTE = 6

DATE:

A7 TABLE 9

EXPERIMENT NO 3 : ELECTROLYSIS OF EFFLUENT SAMPLE B

ANOLYTE: 25L FROM EXP 3 NF

SAMPLE	FARADAYS	THEORETICAL CHANGE (MOL)	VOLUME (l)	Na SPECIES: TOTAL Na (G)	Na SPECIES: OBS CHANGE (MOL)	Na SPECIES: C.EFF. (%)	CO3= / HCO3- SPECIES: TOTAL CO3 (G)	CO3= / HCO3- SPECIES: TOTAL CO2 (G)	CO3= / HCO3- SPECIES: OBS CHANGE (MOL CO3)	CO3= / HCO3- SPECIES: OBS CHANGE (MOL CO2)	CO3= / HCO3- SPECIES: TOT CHANGE (CO3+CO2)	CO3= / HCO3- SPECIES: C EFF. (%)	OH- SPECIES: TOTAL OH (G)	OH- SPECIES: OBS CHANGE (MOL)	OH- SPECIES: C. EFF. (%)	CATH CONC (G/L Na)	ANOL CONC (G/L Na)
ANOLYTE	0,0	0,0	25,0	305			195	400									12,2
CATHOLYTE			13,0	978				31					620			75,2	
ABS.COL.			50,0					350									
ANOLYTE	4,1	8,2	24,4														
CATHOLYTE			13,7	1032	2,3	57							732	6,6	80	75,3	
ABS.COL.			50,0					405	0,0	1,3	1,3	15					
ANOLYTE	6,6	13,2	23,6	37,8	11,6	88	0	54	3,3	7,9	11,2	96					1,6
CATHOLYTE			13,7	1099	5,3	40		55					738	6,9	53	80,2	
ABS.COL.			50,0					640		6,6	6,6	50					

COMMENTS: NOTE : % OF TOTAL ANOLYTE CO3 TRANSFERRED TO CATHOLYTE = 6

DATE:

A7 TABLE 10

EXPERIMENT NO 4: CARBONATION

ANOLYTE: 50L AT 40G/L NA2CO3 & 50G/L NAHCO3

SAMPLE	FARADAYS	THEORETICAL CHANGE (MOL)	VOLUME (l)	Na SPECIES TOTAL Na (G)	Na SPECIES OBS CHANGE (MOL)	Na SPECIES C.EFF. (%)	CO3= / HCO3- SPECIES TOTAL CO3 (G)	CO3= / HCO3- SPECIES TOTAL CO2 (G)	CO3= / HCO3- SPECIES OBS CHANGE (MOL CO3)	CO3= / HCO3- SPECIES OBS CHANGE (MOL CO2)	CO3= / HCO3- SPECIES TOT CHANGE (CO3+CO2)	CO3= / HCO3- SPECIES C EFF. (%)	OH- SPECIES TOTAL OH (G)	OH- SPECIES OBS CHANGE (MOL)	OH- SPECIES C. EFF. (%)	CATH CONC (G/L Na)	ANOL CONC (G/L Na)
ANOLYTE	0,0	0,0	50,0	1500			1230	1675									30,0
CATHOLYTE			12,0	844				43					560			70,3	
ABS.COL.			60,0					270									
ANOLYTE	8,5	17,0	49,4	1235	11,5	68	450	1864	13,0	0,0	13,0	76					25,0
CATHOLYTE			13,2	1056	9,2	54							747	11,0	65	80,0	
ABS.COL.			60,0					378		2,5	2,5	14					
ANOLYTE	10,9	21,8	47,5	917	25,3	100	247	1435	16,4	5,5	21,9	100					19,3
CATHOLYTE			14,5	1354	22,2	100							914	20,8	96	93,4	
ABS.COL.			60,0					822		12,5	12,5	58					
ANOLYTE	27,9	55,8	45,0	509	43,1	77	212	783	17,0	20,3	37,3	67					11,3
CATHOLYTE			15,6	1635	34,4	62							1125	33,2	60	104,8	
ABS.COL.			60 + 60					822+738		12.5+13.6	26,1	47					
ANOLYTE	35,7	71,4	43,2	225	55,4	78	78	337	19,2	30,4	49,6	43					5,2
CATHOLYTE			16,8	1828	42,8	60		67		1,0			1326	45,1	63	108,8	
ABS.COL.			120+40					1560+476		26.1+8.7	34,8	49					

COMMENTS: NOTE 1: TOTAL CO2 CONCENTRATION IN 2ND AND 3RD FEEDS TO ABS COLUMN TAKEN AS 2.3G/L

2: % OF TOTAL ANOLYTE CO3 TRANSFERRED TO CATHOLYTE = 3

DATE:

A7 TABLE 11

EXPERIMENT NO 4 : ELECTROLYSIS OF EFFLUENT SAMPLE A

ANOLYTE: 30L FROM EXP 4 NF

SAMPLE	FARADAYS	THEORET-ICAL CHANGE (MOL)	VOLUME (l)	Na SPECIES TOTAL Na (G)	Na SPECIES OBS CHANGE (MOL)	Na SPECIES C.EFF. (%)	CO3= / HCO3- SPECIES TOTAL CO3 (G)	CO3= / HCO3- SPECIES TOTAL CO2 (G)	CO3= / HCO3- SPECIES OBS CHANGE (MOL CO3)	CO3= / HCO3- SPECIES OBS CHANGE (MOL CO2)	CO3= / HCO3- SPECIES TOT CHANGE (CO3+CO2)	CO3= / HCO3- SPECIES C EFF. (%)	OH- SPECIES TOTAL OH (G)	OH- SPECIES OBS CHANGE (MOL)	OH- SPECIES C. EFF. (%)	CATH CONC (G/L Na)	ANOL CONC (G/L Na)
ANOLYTE	0,0	0,0	30,0	216			111	312									7,2
CATHOLYTE			15,0	917				81					587			61,1	
ABS.COL.			30,0					75									
ANOLYTE	5,4	10,8	28,6	114	4,4	41	80	143	0,5	3,8	4,3	40					4,0
CATHOLYTE			15,1	1031	5,0	46							732	8,5	79	68,3	
ABS.COL.			30,0					369		6,7	6,7	62					
ANOLYTE	7,8	15,6	27,5	8,3	9,0	58	0	8	1,9	6,9	8,8	56					0,3
CATHOLYTE			15,1	1075	6,9	44		79					732	8,6	55	71,2	
ABS.COL.			30,0					327		5,7	5,7	37					

COMMENTS:

DATE:

7 TABLE 12

EXPERIMENT NO 4: ELECTROLYSIS OF EFFLUENT SAMPLE B

ANOLYTE: 30L FROM EXP 4 NF

SAMPLE	FARADAYS	THEORETICAL CHANGE (MOL)	VOLUME (l)	Na SPECIES TOTAL Na (G)	Na SPECIES OBS CHANGE (MOL)	Na SPECIES C.EFF. (%)	$CO_3^{=}$ / HCO_3^- SPECIES TOTAL CO3 (G)	TOTAL CO2 (G)	OBS CHANGE (MOL CO3)	OBS CHANGE (MOL CO2)	TOT CHANGE (CO3+CO2)	C EFF. (%)	OH^- SPECIES TOTAL OH (G)	OBS CHANGE (MOL)	C. EFF. (%)	CATH CONC (G/L Na)	ANOL CONC (G/L Na)
ANOLYTE	0,0	0,0	30,0	216			111	312									7,2
CATHOLYTE			12,0	742				62					532			61,8	
ABS.COL.			60,0					402									
ANOLYTE	5,1	10,2	28,6	100	5,0	49	51	123	1,0	4,3	5,3	42					3,5
CATHOLYTE			12,7	897	6,7	66							596	3,8	37	70,6	
ABS.COL.			60,0					612		4,8	4,8	47					
ANOLYTE	8,1	16,2	27,8	17	8,7	53	0	19	1,9	6,7	8,6	53					0,6
CATHOLYTE			12,7	946	8,9	55							641	6,4	40	74,5	
ABS.COL.			60,0					696		6,7	6,7	41					
ANOLYTE	8,4	16,8	27,2	8	9,0	54	0	19	1,9	6,7	8,6	51					0,3
CATHOLYTE			12,7	939	8,6	51		60					626	5,5	33	73,9	
ABS.COL.			60,0					684		6,4	6,4	38					

OMMENTS:

DATE:

A7 TABLE 13

EXPERIMENT NO 4: ELECTROLYSIS OF EFFLUENT SAMPLE C

ANOLYTE: 30L FROM EXP 4 NF

SAMPLE	FARADAYS	THEORETICAL CHANGE (MOL)	VOLUME (l)	Na SPECIES			$CO_3^=$ / HCO_3^- SPECIES						OH- SPECIES			CATH CONC	ANOL CONC
				TOTAL Na (G)	OBS CHANGE (MOL)	C.EFF. (%)	TOTAL CO3 (G)	TOTAL CO2 (G)	OBS CHANGE (MOL CO3)	OBS CHANGE (MOL CO2)	TOT CHANGE (CO3+CO2)	C EFF. (%)	TOTAL OH (G)	OBS CHANGE (MOL)	C. EFF. (%)	(G/L Na)	(G/L Na)
ANOLYTE	0,0	0,0	30,0	216			111	312									7,2
CATHOLYTE			12,0	740				48					550			61,7	
ABS.COL.			30,0					87									
ANOLYTE	1,5	3,0	29,8	161	2,4	80	89	65	0,4	5,6	6,0	100					5,4
CATHOLYTE			12,0	752	0,5	17							565	0,9	30	62,7	
ABS.COL.			30,0					126		0,9	0,9	30					
ANOLYTE	6,5	13,0	27,9	14	8,8	68	0	8	1,9	6,9	8,8	68					0,5
CATHOLYTE			12,2	844	4,5	35		61		0,3			584	2,0	15	69,2	
ABS.COL.			30,0					360		6,2	6,2	48					

COMMENTS: NOTE: % OF TOTAL ANOLYTE CO3 TRANSFERRED TO CATHOLYTE = 4

DATE:

A7 TABLE 14

EXPERIMENT NO 5: CARBONATION

ANOLYTE: 50L AT 40G/L NA2CO3 AND 50G/L NAHCO3

SAMPLE	FARADAYS	THEORETICAL CHANGE (MOL)	VOLUME (l)	Na SPECIES: TOTAL Na (G)	Na SPECIES: OBS CHANGE (MOL)	Na SPECIES: C.EFF. (%)	CO3= / HCO3- SPECIES: TOTAL CO3 (G)	CO3= / HCO3- SPECIES: TOTAL CO2 (G)	CO3= / HCO3- SPECIES: OBS CHANGE (MOL CO3)	CO3= / HCO3- SPECIES: OBS CHANGE (MOL CO2)	CO3= / HCO3- SPECIES: TOT CHANGE (CO3+CO2)	CO3= / HCO3- SPECIES: C EFF. (%)	OH- SPECIES: TOTAL OH (G)	OH- SPECIES: OBS CHANGE (MOL)	OH- SPECIES: C. EFF. (%)	CATH CONC (G/L Na)	ANOL CONC (G/L Na)
ANOLYTE	0,0	0,0	50,0	1575			1075	1900									31,5
CATHOLYTE			15,0	789				45					516			52,6	
ABS.COL.			60,0					138									
ANOLYTE	20,5	41,0	47,2	1001	25,0	61	401	1525	11,2	8,5	19,7	48					21,2
CATHOLYTE			18,2	1363	25,0	61		86		0,9			842	19,2	47	74,9	
ABS.COL.			60,0					486		7,9	7,9	19					
ANOLYTE	26,7	53,4	45,5	719	37,2	70	282	1083	13,2	18,6	31,8	60					15,8
CATHOLYTE			18,9	1453	28,9	54		125		1,8			926	24,1	45	76,9	
ABS.COL.			60,0					606		10,6	10,6	20					
ANOLYTE	36,3	72,6	44,7	483	47,5	65	18	907	17,6	22,6	40,2	55					10,8
CATHOLYTE			22,0	1877	47,3	65		183		4,2			1230	42,0	58	85,3	
ABS.COL.			60 + 60														

COMMENTS: NOTE : 1) TOTAL CO2 CONCENTRATION IN 2ND 60L SAMPLE TO ABS COLUMN TAKEN AS 2.3G/L

2) % TOTAL ANOLYTE CO3 TRANSFERRED TO CATHOLYTE = 10

DATE:

A7 TABLE 15

EXPERIMENT NO 5 : ELECTROLYSIS OF EFFLUENT SAMPLE A

ANOLYTE: 30L FROM EXP 5 NF

SAMPLE	FARADAYS	THEORET-ICAL CHANGE (MOL)	VOLUME (l)	Na SPECIES			CO3= / HCO3- SPECIES						OH- SPECIES			CATH CONC (G/L Na)	ANOL CONC (G/L Na)
				TOTAL Na (G)	OBS CHANGE (MOL)	C.EFF. (%)	TOTAL CO3 (G)	TOTAL CO2 (G)	OBS CHANGE (MOL CO3)	OBS CHANGE (MOL CO2)	TOT CHANGE (CO3+CO2)	C EFF. (%)	TOTAL OH (G)	OBS CHANGE (MOL)	C. EFF. (%)		
ANOLYTE	0,0	0,0	30,0	153			75	204									5,1
CATHOLYTE			15,0	858				71					554			57,2	
ABS.COL.			30,0					24									
ANOLYTE	2,5	5,0	29,2	73	3,5	70	23	120	0,9	1,9	2,8	56					2,5
CATHOLYTE			15,3	938	5,2	100							791	13,9	100	61,3	
ABS.COL.			30,0					108		1,9	1,9	38					
ANOLYTE	4,6	9,2	28,1	8	6,3	69	0	34	1,3	3,9	5,2	57					0,3
CATHOLYTE			15,7	1060	9,6	100		63					604	2,9	32	68,8	
ABS.COL.			30,0					240		4,9	4,9	53					

COMMENTS:

DATE:

A7 TABLE 16

EXPERIMENT NO 5 : ELECTROLYSIS OF EFFLUENT SAMPLE B

ANOLYTE: 30L FROM EXP 5 NF

SAMPLE	FARADAYS	THEORETICAL CHANGE (MOL)	VOLUME (l)	Na SPECIES			$CO_3^=$ / HCO_3^- SPECIES						OH^- SPECIES			CATH CONC (G/L Na)	ANOL CONC (G/L Na)
				TOTAL Na (G)	OBS CHANGE (MOL)	C.EFF. (%)	TOTAL CO_3 (G)	TOTAL CO_2 (G)	OBS CHANGE (MOL CO_3)	OBS CHANGE (MOL CO_2)	TOT CHANGE (CO_3+CO_2)	C EFF. (%)	TOTAL OH (G)	OBS CHANGE (MOL)	C. EFF. (%)		
ANOLYTE	0,0	0,0	30,0	90			69	159									4,3
CATHOLYTE			13,0	677				47					439			52,1	
ABS.COL.			60,0					234									
ANOLYTE	3,4	6,8	28,6	20	3,0	45	6	31	1,1	2,9	4,0	59					0,7
CATHOLYTE			13,7	811	5,8	86							670	13,6	100	59,2	
ABS.COL.			60,0					420		4,2	4,2	62					
ANOLYTE	3,8	7,2	28,4	8	3,6	50	0	20	1,2	3,2	4,4	61					0,3
CATHOLYTE			15,5	970	12,7	100		40					596	7,6	100	62,6	
ABS.COL.			60,0					438		4,6	4,6	64					

COMMENTS:

DATE:

A7 TABLE 17

EXPERIMENT NO 5 : ELECTROLYSIS OF EFFLUENT SAMPLE C

ANOLYTE: 20L FROM EXP 5 NF

SAMPLE	FARADAYS	THEORETICAL CHANGE (MOL)	VOLUME (l)	Na SPECIES: TOTAL Na (G)	Na SPECIES: OBS CHANGE (MOL)	Na SPECIES: C.EFF. (%)	CO3= / HCO3- SPECIES: TOTAL CO3 (G)	CO3= / HCO3- SPECIES: TOTAL CO2 (G)	CO3= / HCO3- SPECIES: OBS CHANGE (MOL CO3)	CO3= / HCO3- SPECIES: OBS CHANGE (MOL CO2)	CO3= / HCO3- SPECIES: TOT CHANGE (CO3+CO2)	CO3= / HCO3- SPECIES: C EFF. (%)	OH- SPECIES: TOTAL OH (G)	OH- SPECIES: OBS CHANGE (MOL)	OH- SPECIES: C. EFF. (%)	CATH CONC (G/L Na)	ANOL CONC (G/L Na)
ANOLYTE	0,0	0,0	20,0	116			46	106									5,8
CATHOLYTE			12,0	601				23					367			50,1	
ABS.COL.			20,0					32									
ANOLYTE	2,2	4,4	19,7	33	3,6	82	10	47	0,6	1,3	1,9	43					1,7
CATHOLYTE			12,4	671	3,0	69							420	3,1	71	54,1	
ABS.COL.			20,0														
ANOLYTE	2,9	5,8	19,2	6	4,8	82	0	8	0,8	2,2	3,0	52					0,3
CATHOLYTE			12,7	716	5,0	86		76		1,2			398	1,8	30	56,4	
ABS.COL.			20,0					136		2,4	2,4	41					

COMMENTS:

DATE:

A7 TABLE 18

EXPERIMENT NO 6: CARBONATION

ANOLYTE: 50L AT 40G/L NA2CO3 & 50G/L NAHCO3

SAMPLE	FARADAYS	THEORETICAL CHANGE (MOL)	VOLUME (l)	Na SPECIES TOTAL Na (G)	Na SPECIES OBS CHANGE (MOL)	Na SPECIES C.EFF. (%)	CO3= / HCO3- SPECIES TOTAL CO3 (G)	TOTAL CO2 (G)	OBS CHANGE (MOL CO3)	OBS CHANGE (MOL CO2)	TOT CHANGE (CO3+CO2)	C EFF. (%)	OH- SPECIES TOTAL OH (G)	OH- SPECIES OBS CHANGE (MOL)	OH- SPECIES C. EFF. (%)	CATH CONC (G/L Na)	ANOL CONC (G/L Na)
ANOLYTE	0,0	0,0	50,0	1425			995	1215									28,5
CATHOLYTE			15,0	917				50					656			61,1	
ABS.COL.			60,0					102									
ANOLYTE	17,1	34,2	47,2	977	19,5	57	307	1694									20,7
CATHOLYTE			18,2	1389	20,5	60							985	19,4	57	76,3	
ABS.COL.			60,0					246		3,3	3,3	10					
ANOLYTE	21,9	43,8	46,7	934	21,3	49	257	1541	0,8	35,0	4,3	45					20,0
CATHOLYTE			18,9	1450	23,2	53										76,7	
ABS.COL.			60,0					462		8,2	8,2	19	1175	30,5	70		
ANOLYTE	27,7	55,4	35,6	623	34,9	63	164	975	2,4	16,3	18,7	88					17,5
CATHOLYTE			19,6	1543	27,2	49										78,7	
ABS.COL.			60 + 60					462+306		8.2 + 3.8	12,0	22	1127	27,7	50		
ANOLYTE	31,8	63,6	44,7	572	37,1	58	152	718	2,6	22,2	24,8	84					12,8
CATHOLYTE			20,1	1592	29,3	46		90		0,9			1234	34,0	53	79,2	
ABS.COL.			120+40					768+148		12 + 1.3	13,3	21					

COMMENTS: COMMENTS: NOTE 1) CURRENT EFFICIENCY OF CHANGE IN CARBONATE SPECIES IN ANOLYTE CALCULATED USING 17.1F AS START

2) TOTAL CO2 CONCENTRATION IN 2ND AND 3RD FEEDS TO ABS COLUMN TAKEN AS 2.3G/L

3) % OF TOTAL ANOLYTE CO3 TRANSFERRED TO CATHOLYTE = 3

DATE:

A7 TABLE 19

EXPERIMENT NO 7 : CARBONATION

ANOLYTE: 50 L AT 40G/L NA2CO3 & 50G/L NAHCO3

SAMPLE	FARADAYS	THEORETICAL CHANGE (MOL)	VOLUME (l)	Na SPECIES TOTAL Na (G)	Na SPECIES OBS CHANGE (MOL)	Na SPECIES C.EFF. (%)	CO3= / HCO3- SPECIES TOTAL CO3 (G)	TOTAL CO2 (G)	OBS CHANGE (MOL CO3)	OBS CHANGE (MOL CO2)	TOT CHANGE (CO3+CO2)	C EFF. (%)	OH- SPECIES TOTAL OH (G)	OBS CHANGE (MOL)	C. EFF. (%)	CATH CONC (G/L Na)	ANOL CONC (G/L Na)
ANOLYTE	0,0	0,0	50,0	1440			1050	1675									28,8
CATHOLYTE			15,0	428				36					316			28,5	
ABS.COL.			60,0					96									
ANOLYTE	11,2	22,4	48,6	1128	13,6	61	642	1492	6,8	4,2	11,0	49					23,2
CATHOLYTE			16,5	757	14,3	64							535	12,9	58	45,9	
ABS.COL.			60,0					150		1,2	1,2	5					
ANOLYTE	21,7	43,4	46,1	770	29,1	67	355	1153	11,6	11,9	23,5	54					16,7
CATHOLYTE			18,0	1109	29,6	68							668	20,7	48	61,6	
ABS.COL.			60,0					732		14,5	14,5	33					
ANOLYTE	25,7	50,4	45,0	617	35,8	71	280	837	12,8	19,1	31,9	63					13,7
CATHOLYTE			18,6	1293	37,6	75							718	23,7	47	69,5	
ABS.COL.			60 + 60					732+690		14,5+12,6	27,1	54					
ANOLYTE	40,5	81,0	41,2	202	53,8	66	115	293	15,6	31,4	47,0	58					4,9
CATHOLYTE			20,3	1778	58,7	72		71		0,8			1052	43,3	53	87,6	
ABS.COL.			60 + 60					732+780		14.5+14.6	29,1	36					

COMMENTS: NOTE 1) TOTAL CO2 CONCENTRATION IN 2ND 60L FEED TO ABS COLUMN TAKEN AS 2.3G/L
2) % OF TOTAL ANOLYTE CO3 TRANSFERRED TO CATHOLYTE = 2

DATE:

A7 TABLE 20

EXPERIMENT NO 7: ELECTROLYSIS OF EFFLUENT SAMPLE A

ANOLYTE: 25L FROM EXP 7 NF

SAMPLE	FARADAYS	THEORETICAL CHANGE (MOL)	VOLUME (l)	Na SPECIES			CO3= / HCO3- SPECIES						OH- SPECIES			CATH CONC (G/L Na)	ANOL CONC (G/L Na)
				TOTAL Na (G)	OBS CHANGE (MOL)	C.EFF. (%)	TOTAL CO3 (G)	TOTAL CO2 (G)	OBS CHANGE (MOL CO3)	OBS CHANGE (MOL CO2)	TOT CHANGE (CO3+CO2)	C EFF. (%)	TOTAL OH (G)	OBS CHANGE (MOL)	C. EFF. (%)		
ANOLYTE	0,0	0,0	25,0	130			80	173									5,2
CATHOLYTE			15,0	1397				57					1016			93,1	
ABS.COL.			25,0					35									
ANOLYTE	4,3	8,6	14,7	28	4,4	52	24	29	0,9	3,3	4,2	49					1,9
CATHOLYTE			15,8	1585	8,2	94							1103	5,1	60	100,3	
ABS.COL.			25,0					120		1,9	1,9	22					
ANOLYTE	5,3	10,6	13,5	5	5,4	51	0	5	1,3	3,8	5,1	48					0,4
CATHOLYTE			15,3	1597	8,7	82		72		0,3			1447	25,0	100	104,4	
ABS.COL.			25,0					178		3,3	3,3	31					

COMMENTS: NOTE : % OF TOTAL ANOLYTE CO3 TRANSFERRED TO CATHOLYTE = 8

DATE:

A7 TABLE 21

EXPERIMENT NO 7 : ELECTROLYSIS OF EFFLUENT SAMPLE B

ANOLYTE: 25L FROM EXP 7 NF

SAMPLE	FARADAYS	THEORETICAL CHANGE (MOL)	VOLUME (l)	Na SPECIES TOTAL Na (G)	Na SPECIES OBS CHANGE (MOL)	Na SPECIES C.EFF. (%)	CO3= / HCO3- SPECIES TOTAL CO3 (G)	TOTAL CO2 (G)	OBS CHANGE (MOL CO3)	OBS CHANGE (MOL CO2)	TOT CHANGE (CO3+CO2)	C EFF. (%)	OH- SPECIES TOTAL OH (G)	OBS CHANGE (MOL)	C. EFF. (%)	CATH CONC (G/L Na)	ANOL CONC (G/L Na)
ANOLYTE	0,0	0,0	25,0	148			88	195									5,9
CATHOLYTE			15,0	1305				60					900			87,0	
ABS.COL.			50,0					225									
ANOLYTE	3,5	7,0	15,1	42	4,6	66	29	51	1,0	3,3	4,3	61					2,8
CATHOLYTE			15,4	1314	0,4	6							901		0	85,3	
ABS.COL.			50,0					295		1,6	1,6	23					
ANOLYTE	4,6	9,2	10,3	5	6,2	68	2	12	1,4	4,2	5,6	61					0,5
CATHOLYTE			15,5	1476	7,4	80		34					1006	6,2	68	95,2	
ABS.COL.			50,0					305		1,3	1,3	14					

COMMENTS:

DATE:

A7 TABLE 22

EXPERIMENT NO 7: ELECTROLYSIS OF EFFLUENT SAMPLE C

ANOLYTE: 25L FROM EXP 7 NF

SAMPLE	FARADAYS	THEORETICAL CHANGE (MOL)	VOLUME (l)	Na SPECIES			$CO_3^=$ / HCO_3^- SPECIES						OH- SPECIES			CATH CONC	ANOL CONC
				TOTAL Na (G)	OBS CHANGE (MOL)	C.EFF. (%)	TOTAL CO3 (G)	TOTAL CO2 (G)	OBS CHANGE (MOL CO3)	OBS CHANGE (MOL CO2)	TOT CHANGE (CO3+CO2)	C EFF. (%)	TOTAL OH (G)	OBS CHANGE (MOL)	C. EFF. (%)	(G/L Na)	(G/L Na)
ANOLYTE	0,0	0,0	25,0	168			110	188									6,7
CATHOLYTE			15,0	1071				50					741			71,4	
ABS.COL.			25,0					78									
ANOLYTE	4,6	9,2	14,1	42	5,5	60	25	37	1,4	3,4	4,8	52					3,0
CATHOLYTE			15,7	1060									708			67,5	
ABS.COL.			25,0					95		0,3	0,3	3					
ANOLYTE	4,9	9,8	13,6	18	6,5	67	5	19	1,8	3,8	5,6	58					1,3
CATHOLYTE			15,8	989				74		0,5			685			62,6	
ABS.COL.			25,0					210		2,2	2,2	22					

COMMENTS: THE EXPERIMENT WAS HALTED EARLY DUE TO A LEAKAGE OF THE CATHOLYTE ,HENCE CURRENT EFFICIENCIES ON CATHOLYTE NOT CALCULATED. DATE:
________ % OF TOTAL ANOLYTE TRANSFERRED TO CATHOLYTE = 12

A7 TABLE 23

EXPERIMENT NO 8: CARBONATION

ANOLYTE: 50L AT 112G/L NAHCO3

SAMPLE	FARADAYS	THEORETICAL CHANGE (MOL)	VOLUME (l)	Na SPECIES			$CO_3^=$ / HCO_3^- SPECIES						OH- SPECIES			CATH CONC	ANOL CONC
				TOTAL Na (G)	OBS CHANGE (MOL)	C.EFF. (%)	TOTAL CO3 (G)	TOTAL CO2 (G)	OBS CHANGE (MOL CO3)	OBS CHANGE (MOL CO2)	TOT CHANGE (CO3+CO2)	C EFF. (%)	TOTAL OH (G)	OBS CHANGE (MOL)	C. EFF. (%)	(G/L Na)	(G/L Na)
ANOLYTE	0,0	0,0	50,0	1365			530	1325									27,4
CATHOLYTE			15,0	815				50					588			54,3	
ABS.COL.			60,0					102									
ANOLYTE	13,4	26,8	45,2	958	17,7	66	574	1302									21,2
CATHOLYTE			17,5	1174	15,6	58							833	14,4	54	67,1	
ABS.COL.			60,0					630		8,8	8,8	33					
ANOLYTE	23,1	46,2	43,6	689	29,4	64	371	1173	4,6	2,9	7,5	28					15,8
CATHOLYTE			18,9	1334	22,6	49		58		0,2			1083	29,1	63	70,6	
ABS.COL.			60 + 60					630+516		8.8 + 9.4	18,2	39					

COMMENTS:

DATE:

TABLE 24

EXPERIMENT NO 8: ELECTROLYSIS OF EFFLUENT SAMPLE A

ANOLYTE: 25L FROM EXP 8 NF

SAMPLE	FARADAYS	THEORETICAL CHANGE (MOL)	VOLUME (l)	Na SPECIES: TOTAL Na (G)	Na SPECIES: OBS CHANGE (MOL)	Na SPECIES: C.EFF. (%)	CO3= / HCO3- SPECIES: TOTAL CO3 (G)	CO3= / HCO3- SPECIES: TOTAL CO2 (G)	CO3= / HCO3- SPECIES: OBS CHANGE (MOL CO3)	CO3= / HCO3- SPECIES: OBS CHANGE (MOL CO2)	CO3= / HCO3- SPECIES: TOT CHANGE (CO3+CO2)	CO3= / HCO3- SPECIES: C EFF. (%)	OH- SPECIES: TOTAL OH (G)	OH- SPECIES: OBS CHANGE (MOL)	OH- SPECIES: C. EFF. (%)	CATH CONC (G/L Na)	ANOL CONC (G/L Na)
ANOLYTE	0,0	0,0	25,0	205			193,0	275,0									8,2
CATHOLYTE			15,0	1380				18,0					1014,0			92,0	
ABS.COL.			25,0					45,0									
ANOLYTE	5,8	11,6	23,3	77	5,6	48,00	1,0	112,0	3,2	3,7	6,9	59					3,3
CATHOLYTE			15,5	1610	10,0	86,00							1238,0			103,9	
ABS.COL.			25,0					195,0		3,4	3,4	29					
ANOLYTE	8,1	16,2	23,4	77	5,6	35,00	19,0	124,0	2,9	3,4	6,3	39					3,3
CATHOLYTE			15,6	1591	9,2	57,00		65,0		1,1			1120,0			102,0	
ABS.COL.			25,0					203,0		3,6	3,6	22					

COMMENTS: NOTE: ANOLYTE AND CATHOLYTE SAMPLE TAKEN AT 8.1F WITHOUT FLUSHING SAMPLE PORT

DATE:

A7 TABLE 25

EXPERIMENT NO 8: ELECTROLYSIS OF EFFLUENT SAMPLE B

ANOLYTE: 25L FROM EXP 8 NF

SAMPLE	FARADAYS	THEORETICAL CHANGE (MOL)	VOLUME (l)	Na SPECIES TOTAL Na (G)	Na SPECIES OBS CHANGE (MOL)	Na SPECIES C.EFF. (%)	CO3= / HCO3- SPECIES TOTAL CO3 (G)	CO3= / HCO3- SPECIES TOTAL CO2 (G)	CO3= / HCO3- SPECIES OBS CHANGE (MOL CO3)	CO3= / HCO3- SPECIES OBS CHANGE (MOL CO2)	CO3= / HCO3- SPECIES TOT CHANGE (CO3+CO2)	CO3= / HCO3- SPECIES C EFF. (%)	OH- SPECIES TOTAL OH (G)	OH- SPECIES OBS CHANGE (MOL)	OH- SPECIES C. EFF. (%)	CATH CONC (G/L Na)	ANOL CONC (G/L Na)
ANOLYTE	0,0	0,0	25,0	133			85	155									5,3
CATHOLYTE			15,0	1275				45					974			85,0	
ABS.COL.			50,0					195									
ANOLYTE	4,4	8,8	23,7	38	4,1	47	14	55	1,2	2,3	3,5	40					1,6
CATHOLYTE			15,5	1358	3,6	41							978			87,6	
ABS.COL.			50,0					460		6,0	6,0	68					
ANOLYTE	5,1	10,2	23,1	5	5,6	55	0	7	1,4	3,4	4,8	47					0,2
CATHOLYTE			15,6	1382	4,7	46		40					944			88,6	
ABS.COL.			50,0														

COMMENTS:

DATE:

A7 TABLE 26

EXPERIMENT NO 8: ELECTROLYSIS OF EFFLUENT SAMPLE C

ANOLYTE: 35L FROM EXP 8 NF

SAMPLE	FARADAYS	THEORETICAL CHANGE (MOL)	VOLUME (l)	Na SPECIES TOTAL Na (G)	Na SPECIES OBS CHANGE (MOL)	Na SPECIES C.EFF. (%)	CO3= / HCO3- SPECIES TOTAL CO3 (G)	CO3= / HCO3- SPECIES TOTAL CO2 (G)	CO3= / HCO3- SPECIES OBS CHANGE (MOL CO3)	CO3= / HCO3- SPECIES OBS CHANGE (MOL CO2)	CO3= / HCO3- SPECIES TOT CHANGE (CO3+CO2)	CO3= / HCO3- SPECIES C EFF. (%)	OH- SPECIES TOTAL OH (G)	OH- SPECIES OBS CHANGE (MOL)	OH- SPECIES C. EFF. (%)	CATH CONC (G/L Na)	ANOL CONC (G/L Na)
ANOLYTE	0,0		35,0	186			105	228									5,3
CATHOLYTE			15,0	938				39					657			62,5	
ABS.COL.			60,0					330									
ANOLYTE	5,5	11,0	33,8	57	5,6	51	24	57	1,4	3,9	5,3	48					1,7
CATHOLYTE			15,8	1095	6,8	62							665	0,5	4	69,3	
ABS.COL.			60,0					546		4,9	4,9	45					
ANOLYTE	6,9	13,8	33,5	27	6,9	50	17	13	1,5	4,9	6,4	46					0,8
CATHOLYTE			15,9	1130	8,4	60		48		0,2			682	1,5	11	71,1	
ABS.COL.			60,0														

COMMENTS: NOTE: % OF TOTAL ANOLYTE CO3 TRANSFERRED TO CATHOLYTE = 4

DATE:

TABLE 27

EXPERIMENT NO 9: CARBONATION

ANOLYTE: 50L AT 112G/L $NAHCO_3$

SAMPLE	FARADAYS	THEORETICAL CHANGE (MOL)	VOLUME (l)	Na SPECIES TOTAL Na (G)	Na SPECIES OBS CHANGE (MOL)	Na SPECIES C.EFF. (%)	CO3= / HCO3- SPECIES TOTAL CO3 (G)	TOTAL CO2 (G)	OBS CHANGE (MOL CO3)	OBS CHANGE (MOL CO2)	TOT CHANGE (CO3+CO2)	C EFF. (%)	OH- SPECIES TOTAL OH (G)	OH- SPECIES OBS CHANGE (MOL)	OH- SPECIES C. EFF. (%)	CATH CONC (G/L Na)	ANOL CONC (G/L Na)
ANOLYTE	0,0	0,0	50,0	1390			805	1310									27,8
CATHOLYTE			15,0	902				17					575			60,1	
ABS.COL.			60,0					264									
ABS.COL.	7,3	14,6	60,0					618		8,1	8,1	55					
ANOLYTE	8,5	17,0	47,8	1205	8,0	47	808	1520									25,2
CATHOLYTE			16,3	1001	4,3	25							680	6,2	36	61,4	
ABS.COL.			60 + 60					666		9,1	9,1	54					
ANOLYTE	25,1	50,2	44,2	791	26,0	52	535	1083	4,6	9,9	14,5	29					17,9
CATHOLYTE			18,5	1404	21,8	43		20		0,1			975	23,5	47	75,9	
ABS.COL.			60 + 60					666+750		9.1+13.9	23,0	46					

COMMENTS: NOTE 1) CURRENT EFFICIENCIES FOR ANOLYTE CO2 LOSS AT 25.1F CALCULATED RELATIVE TO ANOLYTE AT 8.5F

2) TOTAL CO2 IN 2ND 60L FEED TO ABS COLUMN TAKEN AS 2.3G/L

DATE:

A7 TABLE 28

EXPERIMENT NO 9: ELECTROLYSIS OF EFFLUENT SAMPLE A

ANOLYTE: 30L FROM EXP 9 NF

SAMPLE	FARADAYS	THEORETICAL CHANGE (MOL)	VOLUME (l)	Na SPECIES TOTAL Na (G)	Na SPECIES OBS CHANGE (MOL)	Na SPECIES C.EFF. (%)	$CO_3^=$ / HCO_3^- SPECIES TOTAL CO3 (G)	TOTAL CO2 (G)	OBS CHANGE (MOL CO3)	OBS CHANGE (MOL CO2)	TOT CHANGE (CO3+CO2)	C EFF. (%)	OH- SPECIES TOTAL OH (G)	OH- SPECIES OBS CHANGE (MOL)	OH- SPECIES C. EFF. (%)	CATH CONC (G/L Na)	ANOL CONC (G/L Na)
ANOLYTE	0,0	0,0	30,0	234			102	342									7,8
CATHOLYTE			15,0	1488				17					1128			99,2	
ABS.COL.			30,0					57									
ANOLYTE	7,1	14,2	28,3	79	6,7	47	51	96	0,9	5,6	6,5	46					2,8
CATHOLYTE			16,2	1673	8,0	57							1197	4,1	29	103,3	
ABS.COL.			30,0					285		5,2	5,2	37					
ANOLYTE	8,3	16,6	27,5	14	9,6	58	0	19	1,7	7,3	9,0	54					0,5
CATHOLYTE			16,3	1666	7,7	47		18					1185	3,4	20	102,2	
ABS.COL.			30,0					306		4,2	4,2	25					

COMMENTS:

DATE:

A7 TABLE 29

EXPERIMENT NO 9: ELECTROLYSIS OF EFFLUENT SAMPLE B

ANOLYTE: 25L FROM EXP 9 NF

SAMPLE	FARADAYS	THEORETICAL CHANGE (MOL)	VOLUME (l)	Na SPECIES TOTAL Na (G)	Na SPECIES OBS CHANGE (MOL)	Na SPECIES C.EFF. (%)	CO3= / HCO3- SPECIES TOTAL CO3 (G)	CO3= / HCO3- SPECIES TOTAL CO2 (G)	CO3= / HCO3- SPECIES OBS CHANGE (MOL CO3)	CO3= / HCO3- SPECIES OBS CHANGE (MOL CO2)	CO3= / HCO3- SPECIES TOT CHANGE (CO3+CO2)	CO3= / HCO3- SPECIES C EFF. (%)	OH- SPECIES TOTAL OH (G)	OH- SPECIES OBS CHANGE (MOL)	OH- SPECIES C. EFF. (%)	CATH CONC (G/L Na)	ANOL CONC (G/L Na)
ANOLYTE	0,0	0,0	25,0	148			105	195									5,9
CATHOLYTE			15,0	1088				17					809			72,5	
ABS.COL.			55,0					314									
ANOLYTE	7,2	14,4	24,0	70	3,4	24	48	82	1,0	2,6	3,6	25					2,9
CATHOLYTE			16,0	1283	8,5	59							946	8,1	56	80,2	
ABS.COL.			55,0					616		6,9	6,9	48					
ANOLYTE	7,4	14,8	23,7	7	6,1	41	0	9	1,8	4,2	6,0	41					0,3
CATHOLYTE			16,0	1301	9,3	63		18					918	6,4	43	81,3	
ABS.COL.			55,0					589		6,3	6,3	42					

COMMENTS: NOTE: ANOLYTE SAMPLE AT 7.2F TAKEN WITHOUT FLUSHING VALVE

DATE:

A7 TABLE 30

EXPERIMENT NO 10: CARBONATION

ANOLYTE: 50L AT 112G/L $NAHCO_3$

SAMPLE	FARADAYS	THEORETICAL CHANGE (MOL)	VOLUME (l)	Na SPECIES: TOTAL Na (G)	Na SPECIES: OBS CHANGE (MOL)	Na SPECIES: C.EFF. (%)	CO3= / HCO3- SPECIES: TOTAL CO3 (G)	TOTAL CO2 (G)	OBS CHANGE (MOL CO3)	OBS CHANGE (MOL CO2)	TOT CHANGE (CO3+CO2)	C EFF. (%)	OH- SPECIES: TOTAL OH (G)	OBS CHANGE (MOL)	C. EFF. (%)	CATH CONC (G/L Na)	ANOL CONC (G/L Na)
ANOLYTE	0,0	0,0	50,0	1410			245	1180									28,2
CATHOLYTE			15,0	744				32					554			49,6	
ABS.COL.			60,0					162									
ANOLYTE	13,9	27,8	46,9	596	35,4	100	347	844									12,7
CATHOLYTE			17,2	1030	12,4	45							690	8,0	29	59,9	
ABS.COL.			60,0					774		13,9	13,9	50					
ANOLYTE	33,6	67,2	42,6	396	44,1	66	213	626	0,5	12,6	13,1	19					9,3
CATHOLYTE			18,9	1548	35,0	52		21					1021	27,5	41	81,9	
ABS.COL.			60 + 60					774+822		13.9+15	28,9	43					

COMMENTS:

DATE:

A7 TABLE 31

EXPERIMENT NO 10: ELECTROLYSIS OF EFFLUENT SAMPLE A

ANOLYTE: 25L FROM EXP 10 NF

SAMPLE	FARADAYS	THEORETICAL CHANGE (MOL)	VOLUME (l)	Na SPECIES: TOTAL Na (G)	Na SPECIES: OBS CHANGE (MOL)	Na SPECIES: C.EFF. (%)	CO3= / HCO3- SPECIES: TOTAL CO3 (G)	CO3= / HCO3- SPECIES: TOTAL CO2 (G)	CO3= / HCO3- SPECIES: OBS CHANGE (MOL CO3)	CO3= / HCO3- SPECIES: OBS CHANGE (MOL CO2)	CO3= / HCO3- SPECIES: TOT CHANGE (CO3+CO2)	CO3= / HCO3- SPECIES: C EFF. (%)	OH- SPECIES: TOTAL OH (G)	OH- SPECIES: OBS CHANGE (MOL)	OH- SPECIES: C. EFF. (%)	CATH CONC (G/L Na)	ANOL CONC (G/L Na)
ANOLYTE	0,0	0,0	25,0	190			135	273									7,6
CATHOLYTE			15,0	1443				21					1004				
ABS.COL.			25,0					41								96,2	
ANOLYTE	8,0	16,0	22,5	52	6,0	38	23	72	1,9	4,6	6,5	41					2,3
CATHOLYTE			16,4	1673	10,0	63							1197	11,4	71	102,0	
ABS.COL.			25,0					243		4,6	4,6	29					
ANOLYTE	8,9	17,8	21,7	4	8,0	45	0	0	2,3	6,2	8,5	48					0,2
CATHOLYTE			16,7	1767	14,1	79		18					1236	13,7	77	105,8	
ABS.COL.			25,0					300		5,9	5,9	33					

COMMENTS:

DATE:

A7 TABLE 32

EXPERIMENT NO 10: ELECTROLYSIS OF EFFLUENT SAMPLE B

ANOLYTE: 25L FROM EXP 10 NF

SAMPLE	FARADAYS	THEORETICAL CHANGE (MOL)	VOLUME (l)	Na SPECIES: TOTAL Na (G)	Na SPECIES: OBS CHANGE (MOL)	Na SPECIES: C.EFF. (%)	CO3= / HCO3- SPECIES: TOTAL CO3 (G)	TOTAL CO2 (G)	OBS CHANGE (MOL CO3)	OBS CHANGE (MOL CO2)	TOT CHANGE (CO3+CO2)	C EFF. (%)	OH- SPECIES: TOTAL OH (G)	OBS CHANGE (MOL)	C. EFF. (%)	CATH CONC (G/L Na)	ANOL CONC (G/L Na)
ANOLYTE	0,0	0,0	25,0	193			135	273									7,7
CATHOLYTE			15,0	1227				17					836			81,8	
ABS.COL.			50,0					425									
ANOLYTE	7,2	14,4	22,5	32	7,0	49	36	52	1,7	5,0	6,7	47					1,4
CATHOLYTE			16,2	1369	6,2	43							936	5,9	41	84,5	
ABS.COL.			50,0					555		3,0	3,0	21					
ANOLYTE	8,0	16,0	21,5	6	8,1	51	0	6	2,3	6,1	8,4	53					0,3
CATHOLYTE			16,3	1381	6,7	42		17					949	6,7	42	84,7	
ABS.COL.			50,0					620		4,4	4,4	28					
/WTC																	

COMMENTS:

DATE:

A7 TABLE 33

EXPERIMENT NO 11: CARBONATION

ANOLYTE: 50L AT 112G/L NAHCO3

SAMPLE	FARADAYS	THEORETICAL CHANGE (MOL)	VOLUME (l)	Na SPECIES: TOTAL Na (G)	Na SPECIES: OBS CHANGE (MOL)	Na SPECIES: C.EFF. (%)	CO3= / HCO3- SPECIES: TOTAL CO3 (G)	CO3= / HCO3- SPECIES: TOTAL CO2 (G)	CO3= / HCO3- SPECIES: OBS CHANGE (MOL CO3)	CO3= / HCO3- SPECIES: OBS CHANGE (MOL CO2)	CO3= / HCO3- SPECIES: TOT CHANGE (CO3+CO2)	CO3= / HCO3- SPECIES: C EFF. (%)	OH- SPECIES: TOTAL OH (G)	OH- SPECIES: OBS CHANGE (MOL)	OH- SPECIES: C. EFF. (%)	CATH CONC (G/L Na)	ANOL CONC (G/L Na)
ANOLYTE	0,0	0,0	50,0	1500			325	1850									30,0
CATHOLYTE			15,0	893				17					626			59,5	
ABS.COL.			60,0					552									
ANOLYTE	14,6	29,2	48,9	86,1	27,8	95	406	1315	0,0	12,2	12,2	42					17,6
CATHOLYTE			16,9	1126	10,1	35							820	11,4	39	66,6	
ABS.COL.			60,0					866		7,1	7,1	24					
ANOLYTE	28,5	57,0	44,4	701	34,7	61	475	950	0,0	20,5	20,5	36					15,8
CATHOLYTE			19,8	1606	31,0	54							1152	30,9	54	81,1	
ABS.COL.			60 + 60					866+780		7.1+14.6	21,7	38					
ANOLYTE	44,7	89,4	40,8	282	55,8	62	155	424	2,8	32,4	35,2	39					6,9
CATHOLYTE			21,2	2010	48,6	54		23		0,1			1397	45,4	51	94,8	
ABS.COL.			120+40					1646+520		21.7+9.8	31,5	35					

COMMENTS: NOTE: TOTAL CO2 OF 2ND AND 3RD FEED TO ABS COLUMN TAKEN AS 2.3G/L

DATE:

TABLE 34

EXPERIMENT NO 11: ELECTROLYSIS OF EFFLUENT SAMPLE A

ANOLYTE: 35L FROM EXP 11 NF

SAMPLE	FARADAYS	THEORETICAL CHANGE	VOLUME	Na SPECIES			$CO_3^{=}$ / HCO_3^- SPECIES						OH- SPECIES			CATH CONC	ANOL CONC
		(MOL)	(l)	TOTAL Na (G)	OBS CHANGE (MOL)	C.EFF. (%)	TOTAL CO3 (G)	TOTAL CO2 (G)	OBS CHANGE (MOL CO3)	OBS CHANGE (MOL CO2)	TOT CHANGE (CO3+CO2)	C EFF. (%)	TOTAL OH (G)	OBS CHANGE (MOL)	C. EFF. (%)	(G/L Na)	(G/L Na)
ANOLYTE	0,0	0,0	35,0	252			119	378									7,2
CATHOLYTE			15,0	1274				17					893			84,9	
ABS.COL.			35,0					105									
ANOLYTE	7,9	15,8	31,0	90	10,3	65	105	118	0,2	5,9	6,1	37					2,9
CATHOLYTE			16,1	1573	13,0	82							1129	13,9	88	97,7	
ABS.COL.			35,0					340		5,3	5,3	34					
ANOLYTE	10,1	20,2	29,0	9	10,6	52	0	0	2,0	8,6	10,6	52					0,3
CATHOLYTE			16,5	1607	14,5	72		18					1150	15,1	75	97,4	
ABS.COL.			35,0					361		5,8	5,8	29					

COMMENTS:

DATE:

7 TABLE 35

EXPERIMENT NO 11: ELECTROLYSIS OF EFFLUENT SAMPLE B

ANOLYTE: 35L FROM EXP 11 NF

SAMPLE	FARADAYS	THEORET-ICAL CHANGE (MOL)	VOLUME (l)	Na SPECIES			$CO_3^=$ / HCO_3^- SPECIES						OH- SPECIES			CATH CONC (G/L Na)	ANOL CONC (G/L Na)
-				TOTAL Na (G)	OBS CHANGE (MOL)	C.EFF. (%)	TOTAL CO3 (G)	TOTAL CO2 (G)	OBS CHANGE (MOL CO3)	OBS CHANGE (MOL CO2)	TOT CHANGE (CO3+CO2)	C EFF. (%)	TOTAL OH (G)	OBS CHANGE (MOL)	C. EFF. (%)		
ANOLYTE	0,0	0,0	35,0	252			119	378									7,2
CATHOLYTE			15,0	1316				17					950			87,7	
ABS.COL.			35,0					32									
ANOLYTE	8,3	16,6	32,2	135	5,1	31	93	232	0,4	3,3	3,7	22					4,2
CATHOLYTE			16,1	1470	6,7	40							1082	7,8	47	91,3	
ABS.COL.			35,0					238		4,7	0,0	28					
ANOLYTE	10,8	21,6	31,3	44	9,0	42	16	59	1,7	7,3	9,0	42					1,4
CATHOLYTE			16,2	1499	8,0	37		17					1129	10,5	49	92,5	
ABS.COL.			35,0					256		5,1	5,1	24					

COMMENTS:

DATE:

A7 TABLE 36

EXPERIMENT NO 11: ELECTROLYSIS OF EFFLUENT SAMPLE C

ANOLYTE: 35L FROM EXP 11 NF

SAMPLE	FARADAYS	THEORETICAL CHANGE (MOL)	VOLUME (l)	Na SPECIES TOTAL Na (G)	Na SPECIES OBS CHANGE (MOL)	Na SPECIES C.EFF. (%)	CO3= / HCO3- SPECIES TOTAL CO3 (G)	TOTAL CO2 (G)	OBS CHANGE (MOL CO3)	OBS CHANGE (MOL CO2)	TOT CHANGE (CO3+CO2)	C EFF. (%)	OH- SPECIES TOTAL OH (G)	OBS CHANGE (MOL)	C. EFF. (%)	CATH CONC (G/L Na)	ANOL CONC (G/L Na)
ANOLYTE	0,0	0,0	35,0	259			154	350									7,4
CATHOLYTE			15,0	957				17					657			63,8	
ABS.COL.			35,0					42									
ANOLYTE	8,2	16,4	31,1	34	9,8	60	12	59	2,4	6,6	9,0	55					1,1
CATHOLYTE			15,8	1191	10,2	62							732	4,4	27	75,4	
ABS.COL.			35,0					333		6,6	6,6	40					
ANOLYTE	9,4	18,8	29,7	3	11,1	59	0	0	2,6	8,0	10,6	42					0,1
CATHOLYTE			16,0	1202	10,7	57		17					707	2,9	16	75,1	
ABS.COL.			35,0					350		7,0	7,0	37					
/WTC																	

COMMENTS:

DATE:

A7 TABLE 37

EXPERIMENT NO 12: ELECTROLYSIS OF EFFLUENT SAMPLE A

ANOLYTE: 35L FROM EXP 12 NF

SAMPLE	FARADAYS	THEORETICAL CHANGE (MOL)	VOLUME (l)	Na SPECIES TOTAL Na (G)	Na SPECIES OBS CHANGE (MOL)	Na SPECIES C.EFF. (%)	CO3= / HCO3- SPECIES TOTAL CO3 (G)	TOTAL CO2 (G)	OBS CHANGE (MOL CO3)	OBS CHANGE (MOL CO2)	TOT CHANGE (CO3+CO2)	C EFF. (%)	OH- SPECIES TOTAL OH (G)	OH- SPECIES OBS CHANGE (MOL)	OH- SPECIES C. EFF. (%)	CATH CONC (G/L Na)	ANOL CONC (G/L Na)
ANOLYTE	0,0	0,0	35,0	245			147	319									7,0
CATHOLYTE			20,0	1300				44					850			65,0	
ABS.COL.			70,0					56									
ANOLYTE	9,3	18,6	32,5	88	6,8	37	36	117	1,9	4,6	6,5	35					2,7
CATHOLYTE			21,7	1489	8,2	44							959	6,4	34	68,6	
ABS.COL.			70,0					357		6,8	6,8	37					
ANOLYTE	11,5	23,0	31,2	34	9,2	40	12	31	2,3	6,5	8,8	38					1,1
CATHOLYTE			21,9	1546	10,7	47		48			0,1		1005	9,1	40	70,6	
ABS.COL.			50+40					255+108		4.9+1.7	6,6	29					

COMMENTS:

DATE:

A7 TABLE 38

EXPERIMENT NO 12: ELECTROLYSIS OF EFFLUENT SAMPLE B

ANOLYTE: 40L FROM EXP12 NF

SAMPLE	FARADAYS	THEORETICAL CHANGE (MOL)	VOLUME (l)	Na SPECIES TOTAL Na (G)	OBS CHANGE (MOL)	C.EFF. (%)	CO3= / HCO3- SPECIES TOTAL CO3 (G)	TOTAL CO2 (G)	OBS CHANGE (MOL CO3)	OBS CHANGE (MOL CO2)	TOT CHANGE (CO3+CO2)	C EFF. (%)	OH- SPECIES TOTAL OH (G)	OBS CHANGE (MOL)	C. EFF. (%)	CATH CONC (G/L Na)	ANOL CONC (G/L Na)
ANOLYTE	0,0	0,0	40,0	252			192	352									6,3
CATHOLYTE			15,0	977				33					791			65,1	
ABS.COL.			40,0					56									
ANOLYTE	6,9	13,8	39,1	125	5,5	40	74	137	2,0	4,9	6,9	50					3,2
CATHOLYTE			15,7	978	0,0	0							747		0	62,3	
ABS.COL.			40,0					232		4,0	4,0	29					
ANOLYTE	9,1	18,2	38,5	73	7,8	43	27	81	2,8	6,2	9,0	50					1,9
CATHOLYTE			15,8	1025	2,1	11		40		0,2			804	0,8	4	64,9	
ABS.COL.			40,0					300		5,5	5,5	30					

COMMENTS: % OF TOTAL ANOLYTE CO3 TRANSFERRED TO CATHOLYTE = 3

DATE:

A7 TABLE 39

EXPERIMENT NO 13: CARBONATION

ANOLYTE: 50L AT 80G/L NAHCO3 AND 10G/L NA2CO3

SAMPLE	FARADAYS	THEORETICAL CHANGE (MOL)	VOLUME (l)	Na SPECIES			CO3= / HCO3- SPECIES						OH- SPECIES			CATH CONC (G/L Na)	ANOL CONC (G/L Na)
				TOTAL Na (G)	OBS CHANGE (MOL)	C.EFF. (%)	TOTAL CO3 (G)	TOTAL CO2 (G)	OBS CHANGE (MOL CO3)	OBS CHANGE (MOL CO2)	TOT CHANGE (CO3+CO2)	C EFF. (%)	TOTAL OH (G)	OBS CHANGE (MOL)	C. EFF. (%)		
ANOLYTE	0,0	0,0	50,0	1540			790	2320									30,8
CATHOLYTE			15,0	903				33					600			60,2	
ABS.COL.			50,0					85									
ANOLYTE	15,8	31,6	48,6	685	37,2	100	379	987	6,9	30,3	37,2	100					14,1
CATHOLYTE			17,7	1372	20,4	65							858	15,2	48	77,5	
ABS.COL.			50,0					425		7,7	7,7	24					
ANOLYTE	17,5	35,0	48,4	692	36,9	100	198	1089	9,9	28,0	37,9	100					14,3
CATHOLYTE			17,9	1418	22,4	64							974	22,0	63	79,2	
ABS.COL.			50 + 50					425+470		7.7+8.8	16,5	47					
ANOLYTE	32,6	65,2	42,3	537	43,6	67	220	799	9,5	34,6	45,1	69					12,7
CATHOLYTE			17,9	1364	20,0	31		39		0,1			943	20,2	31	76,2	
ABS.COL.			50 + 50					425+610		7.7+11.9	19,6	30					

COMMENTS:

DATE:

A7 TABLE 40

EXPERIMENT NO 13: ELECTROLYSIS OF EFFLUENT SAMPLE A

ANOLYTE: 30L FROM EXP 13 NF

SAMPLE	FARADAYS	THEORETICAL CHANGE (MOL)	VOLUME (l)	Na SPECIES: TOTAL Na (G)	Na SPECIES: OBS CHANGE (MOL)	Na SPECIES: C.EFF. (%)	CO3= / HCO3- SPECIES: TOTAL CO3 (G)	TOTAL CO2 (G)	OBS CHANGE (MOL CO3)	OBS CHANGE (MOL CO2)	TOT CHANGE (CO3+CO2)	C EFF. (%)	OH- SPECIES: TOTAL OH (G)	OBS CHANGE (MOL)	C. EFF. (%)	CATH CONC (G/L Na)	ANOL CONC (G/L Na)
ANOLYTE	0,0	0,0	30,0	159			90	201									5,3
CATHOLYTE			15,0	966				33					600			64,4	
ABS.COL.			30,0					42									
ANOLYTE	4,6	9,2	28,2	59	4,3	47	34	116	0,9	1,9	2,8	30					2,1
CATHOLYTE			16,1	1090	5,4	59							699	5,8	63	67,7	
ABS.COL.			30,0					141		2,3	2,3	24					
ANOLYTE	7,0	14,0	27,7	11	6,4	46	0	19	1,5	4,1	5,6	40					0,4
CATHOLYTE			16,7	1131	7,2	51		37		0,1			718	6,9	50	67,7	
ABS.COL.			30,0					156		2,6	2,6	19					

COMMENTS: NOTE : % OF TOTAL ANOLYTE CO3 TRANSFERRED TO CATHOLYTE = 2

DATE:

A7 TABLE 41

EXPERIMENT NO 13: ELECTROLYSIS OF EFFLUENT SAMPLE B

ANOLYTE: 30L FROM EXP 13 NF

SAMPLE	FARADAYS	THEORETICAL CHANGE (MOL)	VOLUME (l)	Na SPECIES TOTAL Na (G)	OBS CHANGE (MOL)	C.EFF. (%)	$CO_3^=$ / HCO_3^- SPECIES TOTAL CO3 (G)	TOTAL CO2 (G)	OBS CHANGE (MOL CO3)	OBS CHANGE (MOL CO2)	TOT CHANGE (CO3+CO2)	C EFF. (%)	OH- SPECIES TOTAL OH (G)	OBS CHANGE (MOL)	C. EFF. (%)	CATH CONC (G/L Na)	ANOL CONC (G/L Na)
ANOLYTE	0,0	0,0	30,0	225			147	357									7,5
CATHOLYTE			16,0	904				35					613			56,5	
ABS.COL.			60,0					180									
ANOLYTE	6,9	13,8	27,9	86	6,0	44	0	218	2,5	3,2	5,7	41					3,1
CATHOLYTE			16,4	945									753			57,6	
ABS.COL.			60,0					354		4,0	4,0	29					
ANOLYTE	9,7	19,4	26,1	10	9,3	48	0	18	2,5	7,7	10,2	53					0,4
CATHOLYTE			14,6	894				32					670			61,2	
ABS.COL.			60,0					420		5,5	5,5	28					

COMMENTS: NOTE : LEAK IN CATHOLYTE PUMP CAUSED LOSS, HENCE CATHOLYTE CURRENT EFFICIENCIES NOT CALCULATED

DATE:

A7 TABLE 42

EXPERIMENT NO 13: ELECTROLYSIS OF EFFLUENT SAMPLE C

ANOLYTE: 30L FROM EXP 13 NF

SAMPLE	FARADAYS	THEORETICAL CHANGE (MOL)	VOLUME (l)	Na SPECIES			CO3= / HCO3- SPECIES						OH- SPECIES			CATH CONC (G/L Na)	ANOL CONC (G/L Na)
				TOTAL Na (G)	OBS CHANGE (MOL)	C.EFF. (%)	TOTAL CO3 (G)	TOTAL CO2 (G)	OBS CHANGE (MOL CO3)	OBS CHANGE (MOL CO2)	TOT CHANGE (CO3+CO2)	C EFF. (%)	TOTAL OH (G)	OBS CHANGE (MOL)	C. EFF. (%)		
ANOLYTE	0,0	0,0	30,0	234			180	288									7,8
CATHOLYTE			12,0	691				26					500			57,6	
ABS.COL.			60,0					408									
ANOLYTE	6,1	12,2	28,3	51	7,8	64	91	130	1,5	3,6	5,1	42					1,8
CATHOLYTE			13,4	783	4,0	33							576	4,5	37	58,4	
ABS.COL.			60,0					486		1,8	1,8	15					
ANOLYTE	10,5	21,0	26,0	18	9,4	45	0	34	3,0	5,8	8,8	42					0,7
CATHOLYTE			12,7	766	3,4	15		28					546	2,7	13	60,3	
ABS.COL.			60 + 30														

COMMENTS:

DATE:

7 TABLE 43

EXPERIMENT NO 14: ELECTROLYSIS OF EFFLUENT SAMPLE A

ANOLYTE: 35L FROM EXP 14 NF

SAMPLE	FARADAYS	THEORETICAL CHANGE (MOL)	VOLUME (l)	Na SPECIES			CO3= / HCO3- SPECIES						OH- SPECIES			CATH CONC	ANOL CONC
				TOTAL Na (G)	OBS CHANGE (MOL)	C.EFF. (%)	TOTAL CO3 (G)	TOTAL CO2 (G)	OBS CHANGE (MOL CO3)	OBS CHANGE (MOL CO2)	TOT CHANGE (CO3+CO2)	C EFF. (%)	TOTAL OH (G)	OBS CHANGE (MOL)	C. EFF. (%)	(G/L Na)	(G/L Na)
ANOLYTE	0,0	0,0	35,0	154			109	182									4,4
CATHOLYTE			15,0	930				33					626			62,0	
ABS.COL.			35,0					31									
ANOLYTE	2,3	4,6	34,3	106	2,1	45	0	192	1,8	0,0	1,8	40					3,1
CATHOLYTE			15,4	972	1,8	40							628			63,1	
ABS.COL.			35,0					70		0,7	0,7	14					
ANOLYTE	6,9	13,8	31,2	22	9,6	69	0	37	1,8	3,3	5,1	37					0,7
CATHOLYTE			13,8	879									552			63,7	
ABS.COL.			35,0					228		3,3	3,3	24					

OMMENTS: NOTE: LEAK IN CATHOLYTE PUMP CAUSED LOSS

DATE:

A7 TABLE 44

EXPERIMENT NO 14: ELECTROLYSIS OF EFFLUENT SAMPLE B

ANOLYTE: 30L FROM EXP 14 NF

SAMPLE	FARADAYS	THEORETICAL CHANGE (MOL)	VOLUME (l)	Na SPECIES TOTAL Na (G)	OBS CHANGE (MOL)	C.EFF. (%)	CO3= / HCO3- SPECIES TOTAL CO3 (G)	TOTAL CO2 (G)	OBS CHANGE (MOL CO3)	OBS CHANGE (MOL CO2)	TOT CHANGE (CO3+CO2)	C EFF. (%)	OH- SPECIES TOTAL OH (G)	OBS CHANGE (MOL)	C. EFF. (%)	CATH CONC (G/L Na)	ANOL CONC (G/L Na)
ANOLYTE	0,0	0,0	30,0	150			123	162									5,0
CATHOLYTE			15,0	831				33					549			55,4	
ABS.COL.			60,0					144									
ANOLYTE	3,7	7,4	29,3	88	2,7	36	105	88	0,3	1,7	2,0	27					3,0
CATHOLYTE			15,7	947	5,0	68										60,3	
ABS.COL.			60,0					234		2,0	2,0	27					
ANOLYTE	7,0	14,0	27,9	11	6,0	43	0	42	2,1	2,7		34					0,4
CATHOLYTE			16,2	962	5,7	41		36		0,1			633	4,9	35	59,4	
ABS.COL.			60,0					396		5,7	5,7	41					

COMMENTS: NOTE: % OF TOTAL ANOLYTE CO3 TRANSFERRED TO CATHOLYTE = 2

DATE:

A7 TABLE 45

EXPERIMENT NO 14: ELECTROLYSIS OF EFFLUENT SAMPLE C

ANOLYTE: 35L FROM EXP 14 NF

SAMPLE	FARADAYS	THEORETICAL CHANGE (MOL)	VOLUME (l)	Na SPECIES			$CO_3^{=}$ / HCO_3^- SPECIES						OH- SPECIES			CATH CONC	ANOL CONC
				TOTAL Na (G)	OBS CHANGE (MOL)	C.EFF. (%)	TOTAL CO3 (G)	TOTAL CO2 (G)	OBS CHANGE (MOL CO3)	OBS CHANGE (MOL CO2)	TOT CHANGE (CO3+CO2)	C EFF. (%)	TOTAL OH (G)	OBS CHANGE (MOL)	C. EFF. (%)	(G/L Na)	(G/L Na)
ANOLYTE	0,0	0,0	35,0	200			151	224									5,7
CATHOLYTE			15,0	747				33					524			49,8	
ABS.COL.			35,0					42									
ANOLYTE	2,3	4,6	33,9	136	2,8	60	78	180	1,2	1,0	2,2	48					4,0
CATHOLYTE			15,5	808	2,7	58							603	4,6	100	52,1	
ABS.COL.			35,0					49		0,2	0,2	4					
ANOLYTE	7,6	15,2	31,5	32	7,3	48	0	72	2,5	3,5	6,0	39					1,0
CATHOLYTE			16,4	964	9,4	62		36		0,1			613	5,2	34	58,8	
ABS.COL.			35,0					210		3,8	3,8	25					

COMMENTS: NOTE : % OF TOTAL ANOLYTE CO3 TRANSFERRED TO CATHOLYTE = 2

DATE:

TABLE 46

EXPERIMENT NO 15: CARBONATION

ANOLYTE: 30L FROM EXP 13 CARBONATION & 1KG NAHCO3

SAMPLE	FARADAYS	THEORETICAL CHANGE (MOL)	VOLUME (l)	Na SPECIES TOTAL Na (G)	OBS CHANGE (MOL)	C.EFF. (%)	CO3= / HCO3- SPECIES TOTAL CO3 (G)	TOTAL CO2 (G)	OBS CHANGE (MOL CO3)	OBS CHANGE (MOL CO2)	TOT CHANGE (CO3+CO2)	C EFF. (%)	OH- SPECIES TOTAL OH (G)	OBS CHANGE (MOL)	C. EFF. (%)	CATH CONC (G/L Na)	ANOL CONC (G/L Na)
ANOLYTE	0,0	0,0	30,0	549			375	696									18,3
CATHOLYTE			15,0	759				33					473			50,6	
ABS.COL.			60,0					204									
ANOLYTE	10,9	21,8	28,0	336	9,3	42	34	644	5,7	1,2	6,9	32					12,0
CATHOLYTE			17,0	1020	11,3	52							607	7,9	36	60,0	
ABS.COL.			60,0					600		9,2	9,2	42					
NOLYTE	22,7	45,4	24,2	10	23,4	52	0	36	6,3	15,0	21,3	47					0,4
ATHOLYTE			18,5	1240	20,9	46							801	19,3	43	67,0	
BS.COL.			60 + 60					600+480		9.2+7.8	17,0	37					
NOLYTE	25,4	50,8	14,3	NAHCO3 ADDED TO ANOLYTE													
THOLYTE			18,6	1181	18,3	36		41		0,2			854	22,4	44	63,5	
S.COL.			60,0					600+1146		9.2+22.9	32,1	63					

MENTS: NOTE 1) TOTAL CO2 CONCENTRATION IN 2ND 60L FEED TO ABS COLUMN TAKEN AS 2.3G/L

DATE:

TABLE 47

EXPERIMENT NO 15: ELECTROLYSIS OF EFFLUENT SAMPLE A

ANOLYTE: 30L FROM EXP 15 NF

SAMPLE	FARADAYS	THEORETICAL CHANGE (MOL)	VOLUME (l)	Na SPECIES			$CO_3^=$ / HCO_3^- SPECIES						OH- SPECIES			CATH CONC (G/L Na)	ANOL CONC (G/L Na)
				TOTAL Na (G)	OBS CHANGE (MOL)	C.EFF. (%)	TOTAL CO3 (G)	TOTAL CO2 (G)	OBS CHANGE (MOL CO3)	OBS CHANGE (MOL CO2)	TOT CHANGE (CO3+CO2)	C EFF. (%)	TOTAL OH (G)	OBS CHANGE (MOL)	C. EFF. (%)		
ANOLYTE	0,0	0,0	30,0	162			72	219									5,4
CATHOLYTE			15,0	750				33					485			50,0	
ABS.COL.			60,0					240									
ANOLYTE	1,8	3,6	29,3	103	2,7	74	0	185	1,2	0,8	2,0	56					3,5
CATHOLYTE			15,5	846	4,2	100							527	2,5	69	54,6	
ABS.COL.			60,0					252		0,3	0,3	8					
NOLYTE	5,8	11,6	27,3	22	6,1	52	5	25	1,1	4,4	5,5	47					0,8
ATHOLYTE			16,3	960	9,1	79		35					597	6,6	57	58,9	
BS.COL.			60,0					360		2,7	2,7	24					

MMENTS:

DATE:

A7 TABLE 48

EXPERIMENT NO 15: ELECTROLYSIS OF EFFLUENT SAMPLE B

ANOLYTE: 30L FROM EXP 15 NF

SAMPLE	FARADAYS	THEORETICAL CHANGE (MOL)	VOLUME (l)	Na SPECIES TOTAL Na (G)	Na SPECIES OBS CHANGE (MOL)	Na SPECIES C.EFF. (%)	CO3= / HCO3- SPECIES TOTAL CO3 (G)	TOTAL CO2 (G)	OBS CHANGE (MOL CO3)	OBS CHANGE (MOL CO2)	TOT CHANGE (CO3+CO2)	C EFF. (%)	OH- SPECIES TOTAL OH (G)	OBS CHANGE (MOL)	C. EFF. (%)	CATH CONC (G/L Na)	ANOL CONC (G/L Na)
ANOLYTE	0,0	0,0	30,0	156			78	216									5,2
CATHOLYTE			15,0	600				33					338			40,0	
ABS.COL.			60,0					276									
ANOLYTE	2,0	4,0	29,7	54	4,4	100	36	157	0,7	1,3	2,0	50					3,5
CATHOLYTE			15,5	658	2,5	63							436	5,8	100	42,5	
ABS.COL.			60,0														
ANOLYTE	5,5	11,0	27,2	22	5,8	53	11	16	1,1	4,5	5,6	51					0,8
CATHOLYTE			15,3	690	3,9	36		33					468	7,6	70	45,1	
ABS.COL.			60,0					426		3,4	3,4	31					

COMMENTS:

DATE:

A7 TABLE 49

EXPERIMENT NO 15: ELECTROLYSIS OF EFFLUENT SAMPLE C

ANOLYTE: 24L FROM EXP 15 NF

SAMPLE	FARADAYS	THEORETICAL CHANGE (MOL)	VOLUME (l)	Na SPECIES TOTAL Na (G)	Na SPECIES OBS CHANGE (MOL)	Na SPECIES C.EFF. (%)	CO3= / HCO3- SPECIES TOTAL CO3 (G)	TOTAL CO2 (G)	OBS CHANGE (MOL CO3)	OBS CHANGE (MOL CO2)	TOT CHANGE (CO3+CO2)	C EFF. (%)	OH- SPECIES TOTAL OH (G)	OBS CHANGE (MOL)	C. EFF. (%)	CATH CONC (G/L Na)	ANOL CONC (G/L Na)
ANOLYTE	0,0	0,0	24,0	108			74	122									4,5
CATHOLYTE			17,0	767				37					491			45,1	
ABS.COL.			25,0					30									
ANOLYTE	1,8	3,6	22,6	61	2,0	57	38	84	0,6	0,9	1,5	42					2,7
CATHOLYTE			17,6	991	9,8	100							658	9,8	100	56,3	
ABS.COL.			25,0					33		0,1	0,1	2					
ANOLYTE	4,0	8,0	20,0	14	4,1	51	0	24	1,2	2,2	3,4	43					0,7
CATHOLYTE		4,4	19,1	1070	3,4	78		42		0,1			764	6,2	100	56,0	
ABS.COL.			25,0					88		1,3	1,3	16					

COMMENTS: NOTE 1) THE INITIAL CATHOLYTE SAMPLE WAS TAKEN WITHOUT FLUSHING THE SAMPLE PORTS.
2) CURRENT EFFICIENCIES FOR CATHOLYTE AT 4F CALCULATED RELATIVE TO 1.8F
3) % OF TOTAL ANOLYTE CO3 TRANSFERRED TO CATHOLYTE = 4

DATE:

A7 TABLE 50

EXPERIMENT NO 16: ELECTROLYSIS OF EFFLUENT SAMPLE A

ANOLYTE: 30L FROM EXP 16 NF

SAMPLE	FARADAYS	THEORETICAL CHANGE (MOL)	VOLUME (l)	Na SPECIES			CO3= / HCO3- SPECIES						OH- SPECIES			CATH CONC	ANOL CONC
				TOTAL Na (G)	OBS CHANGE (MOL)	C.EFF. (%)	TOTAL CO3 (G)	TOTAL CO2 (G)	OBS CHANGE (MOL CO3)	OBS CHANGE (MOL CO2)	TOT CHANGE (CO3+CO2)	C EFF. (%)	TOTAL OH (G)	OBS CHANGE (MOL)	C. EFF. (%)	(G/L Na)	(G/L Na)
ANOLYTE	0,0	0,0	30,0	120			114	138									4,0
CATHOLYTE			18,0	932				40					689			51,8	
ABS.COL.			25,0					88									
ANOLYTE	2,2	4,4	29,0	73	2,0	46	46	84	1,1	1,2	2,3	52					2,5
CATHOLYTE			18,3	990	2,5	57							684			54,1	
ABS.COL.			25,0					138		0,8	0,8	18					
ANOLYTE	4,1	8,2	26,4	24	4,2	51	11	32	1,7	3,1	4,8	59					0,9
CATHOLYTE			19,0	1037	4,6	56		42					768	4,7	57	54,6	
ABS.COL.			25,0					173		1,9	1,9	24					

COMMENTS:

DATE:

A7 TABLE 51

EXPERIMENT NO 16: ELECTROLYSIS OF EFFLUENT SAMPLE B

ANOLYTE: 30L FROM EXP 16 NF

SAMPLE	FARADAYS	THEORETICAL CHANGE (MOL)	VOLUME (l)	Na SPECIES			$CO_3^=$ / HCO_3^- SPECIES						OH- SPECIES			CATH CONC	ANOL CONC
				TOTAL Na (G)	OBS CHANGE (MOL)	C.EFF. (%)	TOTAL CO3 (G)	TOTAL CO2 (G)	OBS CHANGE (MOL CO3)	OBS CHANGE (MOL CO2)	TOT CHANGE (CO3+CO2)	C EFF. (%)	TOTAL OH (G)	OBS CHANGE (MOL)	C. EFF. (%)	(G/L Na)	(G/L Na)
ANOLYTE	0,0	0,0	30,0	135			102	177									4,5
CATHOLYTE			15,0	558				33					422			37,2	
ABS.COL.			60,0					108									
ANOLYTE	2,5	5,0	28,3	74	2,7	53	28	99	1,2	1,8	3,0	60					2,6
CATHOLYTE			15,6	722	7,1	100							491	4,1	81	46,3	
ABS.COL.			60,0					264		3,5	3,5	71					
ANOLYTE	4,4	8,8	26,8	27	4,7	53	11	32	1,5	3,3	4,8	55					1,0
CATHOLYTE			16,3	782	9,7	100		36		0,1			541	7,0	80	48,0	
ABS.COL.			60,0					264		3,5	3,5	40					

COMMENTS: NOTE: % OF TOTAL ANOLYTE CO3 TRANSFERRED TO CATHOLYTE = 2

DATE:

A7 TABLE 52

EXPERIMENT NO 17: CARBONATION

ANOLYTE: 20L AT 90G/L NAHCO3

SAMPLE	FARADAYS	THEORETICAL CHANGE (MOL)	VOLUME (l)	Na SPECIES TOTAL Na (G)	OBS CHANGE (MOL)	C.EFF. (%)	CO3= / HCO3- SPECIES TOTAL CO3 (G)	TOTAL CO2 (G)	OBS CHANGE (MOL CO3)	OBS CHANGE (MOL CO2)	TOT CHANGE (CO3+CO2)	C EFF. (%)	OH- SPECIES TOTAL OH (G)	OBS CHANGE (MOL)	C. EFF. (%)	CATH CONC (G/L Na)	ANOL CONC (G/L Na)
ANOLYTE	0,0	0,0	20,0	420			0	758									21,0
CATHOLYTE			15,0	788				33					510			52,5	
ABS.COL.			60,0					78									
ANOLYTE	9,5	19,0	18,3	234	8,1	43	70	364	0,0	9,0	9,0	47					12,8
CATHOLYTE			16,5	1002	9,3	49							645	7,9	42	60,7	
ABS.COL.			60,0					426		7,9	7,9	42					
ANOLYTE	16,5	33,0	16,1	26	17,1	52	26	60	0,0	15,9	15,9	48					1,6
CATHOLYTE			17,8	1150	15,7	48		39		0,1			757	14,5	44	64,6	
ABS.COL.			60 + 60					426+348		14,0	14,0	43					

COMMENTS:

DATE:

47 TABLE 53

EXPERIMENT NO 18: CARBONATION

ANOLYTE: 40L AT 112G/L NAHCO3

SAMPLE	FARADAYS	THEORETICAL CHANGE (MOL)	VOLUME (l)	Na SPECIES: TOTAL Na (G)	Na SPECIES: OBS CHANGE (MOL)	Na SPECIES: C.EFF. (%)	CO3= / HCO3- SPECIES: TOTAL CO3 (G)	CO3= / HCO3- SPECIES: TOTAL CO2 (G)	CO3= / HCO3- SPECIES: OBS CHANGE (MOL CO3)	CO3= / HCO3- SPECIES: OBS CHANGE (MOL CO2)	CO3= / HCO3- SPECIES: TOT CHANGE (CO3+CO2)	CO3= / HCO3- SPECIES: C EFF. (%)	OH- SPECIES: TOTAL OH (G)	OH- SPECIES: OBS CHANGE (MOL)	OH- SPECIES: C. EFF. (%)	CATH CONC (G/L Na)	ANOL CONC (G/L Na)
ANOLYTE	0,0	0,0	32,0	739			285	1405									25,5
CATHOLYTE			20,0	796				66					528			39,8	
ABS.COL.			60,0					3960									
ANOLYTE	19,4	38,8	21,5	301	19,0	49	65	776	3,7	14,3	18,0	46	956	25,2	65		14,0
CATHOLYTE			28,8	1169	16,2	42		317		7,2						40,6	
ABS.COL.			60,0					4400		10,9	10,9	28					
	AT THIS STAGE 137G NA+ WAS ADDED TO THE ANOLYTE AS NAHCO3																
ANOLYTE	36,6	73,2	13,8	8	37,7	52	0	18	1,8	37,5	39,3	54					0,6
CATHOLYTE			34,4	1596	34,8	48		471		10,7			908	22,3	31	46,4	
ABS.COL.			60 + 60														

COMMENTS: NOTE: % OF TOTAL ANOLYTE CO3 TRANSFERRED TO CATHOLYTE = 34

DATE:

7 TABLE 54

EXPERIMENT NO 18A: ELECTROLYSIS OF EFFLUENT SAMPLE A

ANOLYTE: 40L PERM FROM EXP 18 NF

SAMPLE	FARADAYS	THEORETICAL CHANGE (MOL)	VOLUME (l)	Na SPECIES TOTAL Na (G)	Na SPECIES OBS CHANGE (MOL)	Na SPECIES C.EFF. (%)	$CO_3^=$ / HCO_3^- SPECIES TOTAL CO3 (G)	TOTAL CO2 (G)	OBS CHANGE (MOL CO3)	OBS CHANGE (MOL CO2)	TOT CHANGE (CO3+CO2)	C EFF. (%)	OH- SPECIES TOTAL OH (G)	OH- SPECIES OBS CHANGE (MOL)	OH- SPECIES C. EFF. (%)	CATH CONC (G/L Na)	ANOL CONC (G/L Na)
ANOLYTE	0,0	0,0	40,0	1652			1268	2168									41,3
CATHOLYTE			30,0	1416				393					792			47,2	
ABS.COL.			40,0					3964									
ANOLYTE	20,1	40,2	31,6	891	33,1	82	850	1021	7,0	26,1	33,1	82					28,2
CATHOLYTE			34,0					445		1,2			898	6,2	15	58,1	
ABS.COL.			40,0					3768				0					
ANOLYTE	26,4	52,8	31,7	805	36,8	70	684	1052	9,7	23,9	32,8	62					25,4
CATHOLYTE			31,8	2070	28,4	54		382					1135	20,2	38	65,1	
ABS.COL.			40 + 40														
ANOLYTE	39,3	78,6	27,3	685	42,0	53	731	920	8,1	28,4	36,5	46					25,1
ANOLYTE	45,7	91,4	26,4	702	41,3	45	602	834	11,1	30,3	41,4	45					26,6

COMMENTS: NOTE 1) NO CURRENT EFFICIENCIES CALCULATED FROM ABSORPTION COLUMN FEED DUE TO SATURATION OF LIQUOR BY NAHCO3 AND HENCE PRECIPITATION.

2) NO CURRENT EFFICIENCIES FOR CATHOLYTE CALCULATED AFTER 26.4F DUE TO LEAK CAUSING LOSS OF CATHOLYTE

A7 TABLE 55

EXPERIMENT NO 18B: ELECTROLYSIS OF EFFLUENT SAMPLE B

ANOLYTE: 43L FROM EXP 18 NF

SAMPLE	FARADAYS	THEORETICAL CHANGE (MOL)	VOLUME (l)	Na SPECIES TOTAL Na (G)	Na SPECIES OBS CHANGE (MOL)	Na SPECIES C.EFF. (%)	CO3= / HCO3- SPECIES TOTAL CO3 (G)	TOTAL CO2 (G)	OBS CHANGE (MOL CO3)	OBS CHANGE (MOL CO2)	TOT CHANGE (CO3+CO2)	C EFF. (%)	OH- SPECIES TOTAL OH (G)	OBS CHANGE (MOL)	C. EFF. (%)	CATH CONC (G/L Na)	ANOL CONC (G/L Na)
ANOLYTE	0,0	0,0	43,0	2068			1578	2563									48,1
CATHOLYTE			20,0	1404				220					800			70,2	
ABS.COL.			60,0					4794									
ANOLYTE	14,2	28,4	36,0	1379	30,0	100	1105	1757	7,9	18,3	26,2	92					38,3
CATHOLYTE			23,6	1892	21,2	75		361		3,2			1024	13,2	46	80,2	
ABS.COL.								4194									
ANOLYTE	30,6	61,2	30,1	704	59,3	97	521	1162	9,7	31,8	41,5	68					23,4
CATHOLYTE			26,7	2342	40,8	67		409		4,3			1316	30,4	50	87,7	
ABS.COL.			60,0					3846									
AT THIS STAGE THE EXPERIMENT WAS STOPPED OVERNIGHT. A LEAKING VALVE CAUSED ANOLYTE LOSS: INITIAL VOLUME ON RESTARTING = 18L																	
ANOLYTE	30,6	0,0	18,0	421			311	694									
ANOLYTE	34,7	8,2	14,5	262	6,9	84	264	291	0,8	9,2	10,0	69					18,1
CATHOLYTE		69,4	29,5	2354	41,3	60		516		6,7			1304	29,6	43	79,8	
ANOLYTE	40,6	20,0	5,4	47	16,3	81	272	255	0,6	10,0	10,6	53					8,7
CATHOLYTE		81,2	34,8	2610	52,4	65		686		10,6			1451	38,3	47	75,0	

COMMENTS: NOTE: % OF TOTAL ANOLYTE CO3 TRANSFERRED TO CATHOLYTE = 18

DATE:

A7 TABLE 56

EXPERIMENT NO 19A: ELECTROLYSIS OF EFFLUENT SAMPLE A

ANOLYTE: 30L FROM EXP 19 NF

SAMPLE	FARADAYS	THEORETICAL CHANGE (MOL)	VOLUME (l)	Na SPECIES: TOTAL Na (G)	Na SPECIES: OBS CHANGE (MOL)	Na SPECIES: C.EFF. (%)	$CO_3^=$ / HCO_3^- SPECIES: TOTAL CO3 (G)	$CO_3^=$ / HCO_3^- SPECIES: TOTAL CO2 (G)	$CO_3^=$ / HCO_3^- SPECIES: OBS CHANGE (MOL CO3)	$CO_3^=$ / HCO_3^- SPECIES: OBS CHANGE (MOL CO2)	$CO_3^=$ / HCO_3^- SPECIES: TOT CHANGE (CO3+CO2)	$CO_3^=$ / HCO_3^- SPECIES: C EFF. (%)	OH- SPECIES: TOTAL OH (G)	OH- SPECIES: OBS CHANGE (MOL)	OH- SPECIES: C. EFF. (%)	CATH CONC (G/L Na)	ANOL CONC (G/L Na)
ANOLYTE	0,0	0,0	30,0	1158			1065	1575									38,6
CATHOLYTE			20,0	772				88					476			38,6	
ABS.COL.			60,0					4728									
ANOLYTE	11,3	22,6	23,7	730	18,6	82	455	1187	10,2	8,8	19,0	84					30,8
CATHOLYTE			21,1	1299	22,9	100							648	10,2	45	61,6	
ABS.COL.			60,0					4866		3,1	3,1	14					
ANOLYTE	20,1	40,2	17,7	589	24,7	61	138	1012	15,5	12,8	28,3	70					33,3
CATHOLYTE			25,7	1249	20,7	52		617		12,0			524	2,8	7	48,6	
ABS.COL.			60,0					4146									
ANOLYTE	29,6	59,2	5,8	112	45,5	77	182	30	14,7	35,1	49,8	84					19,3
CATHOLYTE			35,8	1597	35,9	61		627		12,2			609	7,8	13	44,6	
ABS.COL.			60,0					4818		2,0							

COMMENTS: NOTE: % OF TOTAL ANOLYTE CO3 TRANSFERRED TO CATHOLYTE = 34

DATE:

Polarisation Data for Experiment 18B

Faradays (F)	Temperature (°C)	Stack Voltage (V)	Cell 1 Voltage (V)	Cell 2 Voltage (V)	Current Density (A/m^2)
0	19	4,3			60
		7,4			600
		9,5			1 000
		10,5			1 500
		11,8			1 800
4,3	41	6,2	3,1	3,0	400
			3,7	3,6	800
		7,5	4,3	4,2	1 200
		10,3	4,9	4,8	1 600
		11,6	5,3	5,5	2 000
		12,6	5,8	6,2	2 600
		14,3	6,6	6,7	3 200
		16,3	7,4	7,8	4 000
		17,1	7,6	8,3	4 300
9,6	49	6,0	3,0	2,9	400
		8,7	4,3	4,1	1 200
		11,0	4,8	5,0	2 000
		11,7	5,2	5,9	2 600
		13,7	5,9	6,9	3 200
		16,6	7,0	8,6	4 000
		25,4	9,8	13,9	5 560
14,2	49	5,4	2,8	2,7	200
		7,0	3,5	3,4	600
		8,9	4,4	4,3	1 200
		11,6	4,7	4,5	1 400
			5,5	5,4	2 000
		14,9	6,9	7,2	3 000
		16,8	7,7	8,1	3 400
20,3	46	5,5	2,7	2,8	200
		7,0	3,6	3,5	600
			4,5	4,5	1 200
		9,3	4,3	4,8	1 400
		11,4	5,5	5,4	1 800
		15,1	6,7	7,7	2 800
		17,3	7,8	8,5	3 200
25,4	40	5,7	2,8	2,8	200
		8,8	4,3	4,3	1 000
		11,7	4,8	6,0	1 800
		14,2	5,7	7,7	2 400
		17,2	6,9	9,9	3 000
30,3	50	5,5	2,7	2,8	200
		7,4	3,8	3,8	700
		10,8	4,4	5,8	1 500
		13,3	5,1	7,9	2 000
		14,7	5,4	7,8	2 200
		17,5	6,1	12,6	2 600
30,3	20	4,1			60
		7,7			500
		9,9			800
		12,9			1 200
		14,5	6,1	8,5	1 400
34,7	40	8,8	4,1	4,6	600
		11,5	5,1	6,1	1 000
		13,3	5,6	7,1	1 200
		15,4	6,1	8,2	1 600
		18,2	6,6	11,1	2 000
		19,4	7,2	12,2	2 200
38,4	42	6,9	3,2	3,6	200
		8,7	3,9	4,7	400
		13,1	5,7	7,2	900
		18,6	7,8	10,3	1 500
		19,9	8,3	11,2	1 600
		22,9	9,4	13,1	1 900
		24,5	8,2	14,1	2 000
		24,8	8,4	16,0	2 100

Cell Operation Using Scaled Electrodes and Conducting Plate

Anolyte	67 g/l $NaHCO_3$
Catholyte	NaOH
Absorption column	38 litres partially carbonated scour effluent

						Sample Analysis								
Time (h)	CD (A/m^2)	Faraday (F)	Overall Volts (V)	Anode-Mem. Volts (V)	Temp (°C)	Sample	Volume (l)	pH	L (mS/cm)	OH^- (g/l)	$CO_3^=$ (g/l)	HCO_3^- (g/l)	Total CO_2 (g/l)	Na (g/l)
0-00	60	0,0	2,5			anolyte	15,0	8,6	39	0,0	5,3	31,1	26,6	17,8
	280		3,5			catholyte	18,0	13,0	29	25,5	3,0	0,0	2,2	41,6
	600		4,9											
	1 200		6,9											
	1 400		7,9											
0-10	1 400	0,6	7,3	3,3										
0-15	1 400	0,7	6,9		30									
0-33	1 400	1,4	6,4		36									
0-55	1 400	2,4	6,1	3,0	43									
1-25	1 400	3,5	5,9	2,7	47									
2-00	1 400	5,1	5,8	2,7	50									
2-25	1 400	6,2	5,8	2,8	53	anolyte	13,3	8,7	35	0,0	4,2	24,6	21,0	13,2
						catholyte	19,6	13,0	33	28,1	3,0	0,0	2,2	43,5

Note: Current efficiencies for Na loss from anolyte = 64 %
Current efficiencies for Na gain in catholyte = 73 %
Carbon dioxide loss from anolyte = 44 %

Cell Operation Using Sanded Electrodes and Conducting Plate

Anolyte	67 g/l $NaHCO_3$
Catholyte	NaOH
Absorption column	38 litres partially carbonated scour effluent

						Sample Analysis								
Time (h)	CD (A/m^2)	Faraday (F)	Overall Volts (V)	Anode-Mem. Volts (V)	Temp (°C)	Sample	Volume (l)	pH	L (mS/cm)	OH^- (g/l)	$CO_3^=$ (g/l)	HCO_3^- (g/l)	Total CO_2 (g/l)	Na (g/l)
0-00	20	0	1,0			anolyte	15,0	8,1	43	0,0	1,2	40,3	30,3	18,8
	320		3,4			catholyte	19,0	13,0	32	27,2	3,0	0,0	2,2	39,8
	600		4,5											
	900		5,2											
	1 200		6,3											
	1 400		6,9											
1-05	1 400		5,8	2,1	2,8									
1-30	1 400	1,2	5,8		2,7									
0-45	1 400	1,9	6,1		2,8									
1-00	1 400	2,6	6,0		2,8									
1-15	1 400	3,2	5,9		2,7									
1-30	1 400	3,8	5,8		2,7									
1-45	1 400	4,5	5,8		2,7									
2-00	1 400	5,1	5,8		2,8									
2-15	1 400	5,9	5,8		2,9									
2-30	1 400	6,3	5,8		2,8	anolyte	13,3	8,5	34	0,0	4,3	24,6	21,1	13,2
						catholyte	20,0	13,0	33	28,9	3,0	0,0	2,2	43,5

Note: Current efficiencies for Na loss from anolyte = 73%
Current efficiencies for Na gain in catholyte = 79 %
Carbon dioxide loss from anolyte = 63 %

APPENDIX 7

SUPPLEMENTARY INVESTIGATIONS INTO PERFORMANCE, SPECIATION AND MODELING OF NANOFILTRATION

This Appendix contains:

Experimental Data to Determine Effects of Electrolyte Characteristics on Nanofiltration Performance

Table A7-1
Results for Experiment 1

Feed	1 g/l Na as sodium carbonate
Initial solution pH	10,9
Pressure	1,3 MPa
Temperature	26 °C

Feed pH	Flux (l/m^2h)	Retention Na (%)	Retention $CO_3^=$ (%)	Retention HCO_3^- (%)	Retention Total CO_2 (%)
6,3	41,4	42,6		72,0	71,1
6,9		46,4		75,3	74,6
7,5	41,0	51,5		79,1	77,7
8,1		53,8		80,7	81,0
8,5		56,4	99,5	81,7	83,8
8,9		59,4	99,7	85,8	
9,4	42,1	65,6	98,5	85,0	87,5
10,0	40,6	78,6	97,5		85,0
10,4		90,3	99,5	24,7	88,1
10,9	31,0	97,4	97,2		92,2

Table A7-2
Results for Experiment 2

Feed	10 g/l Na as sodium carbonate
Initial solution pH	11,2
Pressure	1,3 MPa
Temperature	26 °C

Feed					Permeate				Flux	Retention			
pH	Na (g/l)	$CO_3^=$ (g/l)	HCO_3^- (g/l)	Total CO_2 (g/l)	Na (g/l)	$CO_3^=$ (g/l)	HCO_3^- (g/l)	Total CO_2 (g/l)	(l/m^2h)	Na (%)	$CO_3^=$ (%)	HCO_3^- (%)	Total CO_2 (%)
6,6	10		10	9,6	8,06		4,5	4,75	29,5	19,4		50,6	50,3
7,2	10		12,2	9,6	7,91		4,8	4,27		20,9		55,2	55,3
8,3	10		13,3	9,6	7,15		4,9	3,60	24,7	28,5		62,8	62,4
9,0	10	2,9	9,4	9,6	5,56	0,18	4,2	2,81	20,3	44,4	92,9	54,5	70,6
9,6	10	6,6	4,9	9,6	4,49	0,36	2,9	2,73		55,1	94,7	40,5	71,5
10,6	10	9	0,6	9,6	2,47	0,62	0,6	1,45		75,3	94,7	4,3	84,8
11,2	10	9,8		9,6	1,00	0,74		0,72	90,8	90,0	92,9		92,5

Table A7-3
Results for Experiment 3

Feed	30 g/l Na as sodium carbonate
Initial solution pH	11,5
Pressure	1,3 MPa
Temperature	26 °C

Feed pH	Flux (l/m²h)	Retention Na (%)	$CO_3^=$ (%)	HCO_3^- (%)	Total CO_2 (%)
7,0				42,8	39,1
7,3		16,6			38,3
7,6	17,0	14,5		40,2	43,4
7,9	17,4	18,1		43,8	
8,5	16,2	19,1			47,2
9,1	11,3	24,7	80,2	31,3	
9,6	5,0	43,1	82,0	10,0	55,3

Table A7-4
Results for Experiment 4

Feed	10 g/l Na as sodium carbonate 10 mg/l Ca as calcium chloride 10 mg/l Mg as magnesium hydroxide
Initial solution pH	11,2
Pressure	1,3 MPa
Temperature	26 °C

Feed pH	Retention Na (%)	Ca (%)	Mg (%)
7,2	20,1	55,1	57,4
8,2	25,3	65,6	68,5
9,0	40,6	77,7	79,7
10,0	63,9	86,5	90,0
11,0	85,6	91,5	95,1

Table A7-5
Results for Experiment 5

Feed	10 g/l Na as sodium carbonate 10 mg/l Ca as calcium chloride 10 mg/l Mg as magnesium hydroxide 0,1 g/l EDTA
Initial solution pH	11,2
Pressure	1,3 MPa
Temperature	26 °C

Feed pH	Retention Na (%)	Ca (%)	Mg (%)
7,2	19,7	89	73,1
7,8	24,1	91,3	75,4
9,0	41,5	89,5	86,5
10,0	63,2	93,3	93,0
11,0	85,4	97,5	97,0

Experimental Data for Nanofiltration Tests for Speciation and Transport Modeling

Table A7-6
Results for Experiment 6

Feed	1 g/l Na as sodium carbonate
Initial solution pH	11,0
Pressure	1,3 MPa
Temperature	26 °C

Flux	Sample	pH	π	Cond	Na	OH^-	$CO_3^=$	HCO_3^-	IC	Rejection				
										Cond	Na	$CO_3^=$	HCO_3^-	TIC
(l/m^2h)			(kPa)	(mS/cm)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(%)	(%)	(%)	(%)	(%)
	feed	11,0	111,2	3,67	972	0	1152	220	264					
55,6	perm	10,9	0,0	0,37	8	1	66	0	15	89,9	99,1	94,3	100,0	94,3
	feed	10,4	122,5	3,70	997	0	852	512	265					
58,4	perm	10,1	43,1	0,88	154	0	48	55	25	76,2	84,6	94,4	89,3	90,6
	feed	10,0	138,4	3,78	995	0	540	781	268					
69,8	perm	9,7	45,4	1,43	294	0	30	134	40	62,2	70,5	94,4	82,8	85,1
	feed	9,4	163,4	3,83	997	0	198	1134	272					
70,9	perm	9,2	79,4	2,13	467	0	16	251	55	44,4	53,2	91,9	77,9	79,8
	feed	3,9	163,4	3,86	984	0	33	1330	265					
70,9	perm	8,8	93,0	2,46	544	0	2	325	65	36,3	44,7	93,9	75,6	75,5
	feed	8,1	172,4	3,88	1000	0	0	1293	259					
62,2	perm	8,2	99,8	2,84	638	0	0	421	82	26,8	36,2	N/A	67,4	68,3
	feed	6,9	167,9	4,13	1010	0	0	891	172					
49,1	perm	7,1	115,7	2,90	662	0	0	382	75	29,8	34,5	N/A	57,1	56,4

Table A7-7
Results for Experiment 7

Feed	10 g/l Na as sodium carbonate
Initial solution pH	11,3
Pressure	1,3 MPa
Temperature	26 °C

Flux (l/m^2h)	Sample	pH	π (kPa)	Cond (mS/cm)	Na (mg/l)	OH^- (mg/l)	$CO_3^=$ (mg/l)	HCO_3^- (mg/l)	IC (mg/l)	Rejection Cond (%)	Na (%)	$CO_3^=$ (%)	HCO_3^- (%)	TIC (%)
	feed	11,3	1062	26,70	9700	34	20000	0	2338					
17,3	perm	11,5	238	7,50	2050	0	3950	275	515	71,9	78,9	80,3	N/A	78,0
	feed	10,6	1130	27,10	9363	0	17600	3172	2438					
25,0	perm	10,0	399	9,55	2860	0	2134	1341	515	64,8	69,5	87,9	57,7	78,9
	feed	9,6	1386	28,30	9563	0	9200	7076	2500					
33,6	perm	9,0	874	18,10	5300	0	600	4026	900	36,0	44,6	93,5	43,1	64,0
	feed	9,0	1572	29,50	9638	0	2200	11956	2463					
40,9	perm	8,5	112	23,00	7300	0	0	5774	1150	22,0	24,3	100,0	51,7	53,3
	feed	8,3	1663	30,50	9650	0	0	12932	2538					
41,1	perm	8,1	1302	25,30	8150	0	0	6750	1360	17,0	15,5	N/A	47,8	46,4
	feed	7,2	1695	31,20	10238	0	0	11346	2338					
41,4	perm	7,4	1341	26,00	8150	0	0	6262	1325	16,7	20,4	N/A	44,8	43,3

Table A7-8
Results for Experiment 8

Feed	30 g/l Na as sodium carbonate
Initial solution pH	11,5
Pressure	1,3 MPa
Temperature	26 °C

Flux (l/m^2h)	Sample	pH	π (kPa)	Cond (mS/cm)	Na (mg/l)	OH^- (mg/l)	$CO_3^=$ (mg/l)	HCO_3^- (mg/l)	IC (mg/l)	Rejection Cond (%)	Na (%)	$CO_3^=$ (%)	HCO_3^- (%)	TIC (%)
	feed	11,5	2895	60,6	32000	0	33600	7320	7750					
	feed	10,6	3047	62,4	32000	0	32160	7320	7750					
3,4	perm	10,4	1951	42,6	18875	0	16800	4880	4450	31,7	41,0	47,8	33,3	42,6
	feed	9,6	3717	65,1	30750	0	15360	26840	7300					
9,0	perm	9,2	2711	50,0	19450	0	4800	16226	4250	23,2	36,7	68,8	39,5	41,8
	feed	9,1	4073	68,8	30000	0	4800	35502	7000					
16,7	perm	8,6	3345	58,6	21925	0	1200	21106	4500	14,8	26,9	75,0	40,5	35,7
	feed	8,5	4549	71,0	30750	0	1400	35258	7175					
25,5	perm	8,2	3767	63,6	22875	0	0	22570	4025	10,4	25,6	100,0	36,0	43,9
	feed	7,9	4651	72,0	30250	0	0	33428	6750					
27,8	perm	7,9	3837	66,4	24250	0	0	21960	4025	7,8	19,8	N/A	34,3	40,4

Table A7-9
Results for Experiment 9

Feed	10 g/l Na as sodium carbonate
Initial solution pH	11,3
Pressure	variable
Flow	variable
Temperature	22 °C

Pressure	Flow	Flux	Sample	pH	π	Cond	Na	OH^-	$CO_3^=$	HCO_3^-	IC	Rejection				
(MPa)	(ml/min)	(l/m²h)			(kPa)	(mS/cm)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	Cond (%)	Na (%)	$CO_3^=$ (%)	HCO_3^- (%)	TIC (%)
0,4	445		feed	9,6	1488	29,5	10413	0	4740	7930	2463					
		5,6	perm	9,0	1230	24,1	6950	0	672	8003	1585	18,3	33,3	85,8	-0,9	35,6
	1010		feed	9,6	1488	29,5	10413	0	4740	7930	2463					
		5,1	perm	9,1	1234	24,6	7050	0	696	8406	1660	16,6	32,3	85,3	-6,0	32,6
	1610		feed	9,6	1495	29,8	10413	0	4920	8052	2525					
		4,1	perm	9,1	1218	24,3	6800	0	1152	7747	1680	18,5	34,7	76,6	3,8	33,5
0,85	445		feed	9,6	1482	29,4	10075	0	5280	6344	2438					
		18,5	perm	9,0	1103	21,9	5400	0	624	5478	1200	25,5	46,4	88,2	13,7	50,8
	1010		feed	9,6	1482	29,4	10075	0	5280	6344	2438					
		18,3	perm	9,0	1087	22,0	5700	0	408	5787	1200	25,2	43,4	92,3	8,8	50,8
	1610		feed	9,6	1482	29,4	10075	0	5280	6344	2438					
		17,5	perm	9,0	1105	22,0	5850	0	420	5588	1160	25,2	41,9	92,0	11,9	52,4
1,5	445		feed	9,6	1457	29,3	10638	0	4620	8296	2438					
		42,5	perm	8,9	1001	20,1	7400	0	264	4270	860	31,4	30,4	94,3	48,5	64,7
	1010		feed	9,6	1457	29,3	10638	0	4620	8296	2438					
		43,6	perm	8,9	980	20,1	7700	0	348	3904	860	31,4	27,6	92,5	52,9	64,7
	1610		feed	9,6	1457	29,3	10288	0	4620	8296	2438					
		39,7	perm	8,9	973	19,8	7400	0	336	3904	840	32,4	28,1	92,7	52,9	65,5

Results of Speciation Modeling

Table A7-10
Speciation Modeling of Experiment 6

Feed: 1 g/l Na as sodium carbonate
Initial solution pH: 11,0

Feed pH	Ionic strength (m)	Parameter	Speciation H^+ (m)	Na^+ (m)	$CO_3^=$ (m)	NO_3^- (m)	H_2CO_3 (m)	OH^- (m)	$NaCO_3^-$ (m)	$NaHCO_3$ (m)	HCO_3^- (m)
6,9	4,37E-02	Conc (mol)	1,57E-07	4,37E-02	1,15E-05	2,62E-02	4,19E-03	1,01E-07	4,55E-06	2,97E-04	1,75E-02
		Activity	1,29E-07	3,61E-02	5,34E-06	2,16E-02	4,23E-03	8,37E-08	3,76E-06	3,00E-04	1,45E-02
		Gamma	8,26E-01	8,26E-01	4,65E-01	8,26E-01	1,01E+00	8,26E-01	8,26E-01	1,01E+00	8,26E-01
8,1	4,38E-02	Conc (mol)	9,87E-09	4,36E-02	2,19E-04	2,20E-02	3,17E-04	1,61E-06	8,64E-05	3,55E-04	2,10E-02
		Activity	8,15E-09	3,60E-02	1,02E-04	1,82E-02	3,20E-04	1,33E-06	7,13E-05	3,59E-04	1,74E-02
		Gamma	8,26E-01	8,26E-01	4,65E-01	8,26E-01	1,01E+00	8,26E-01	8,26E-01	1,01E+00	8,26E-01
8,9	4,45E-02	Conc (mol)	1,58E-09	4,32E-02	1,29E-03	2,02E-02	4,78E-05	1,01E-05	5,04E-04	3,31E-04	1,98E-02
		Activity	1,30E-09	3,56E-02	5,99E-04	1,67E-02	4,83E-05	8,29E-06	4,16E-04	3,34E-04	1,64E-02
		Gamma	8,24E-01	8,25E-01	4,63E-01	8,25E-01	1,01E+00	8,25E-01	8,25E-01	1,01E+00	8,25E-01
9,4	4,59E-02	Conc (mol)	4,98E-10	4,24E-02	3,53E-03	1,71E-02	1,27E-05	3,21E-05	1,34E-03	2,75E-04	1,69E-02
		Activity	4,10E-10	3,49E-02	1,62E-03	1,41E-02	1,29E-05	2,64E-05	1,10E-03	2,78E-04	1,39E-02
		Gamma	8,23E-01	8,23E-01	4,58E-01	8,23E-01	1,01E+00	8,23E-01	8,23E-01	1,01E+00	8,23E-01
10,0	4,94E-02	Conc (mol)	1,24E-10	4,08E-02	8,66E-03	1,01E-02	1,88E-06	1,30E-04	3,09E-03	1,57E-04	1,01E-02
		Activity	1,02E-10	3,34E-02	3,89E-03	8,29E-03	1,90E-06	1,06E-04	2,53E-03	1,58E-04	8,26E-03
		Gamma	8,19E-01	8,18E-01	4,49E-01	8,18E-01	1,01E+00	8,18E-01	8,19E-01	1,01E+00	8,18E-01
10,4	5,19E-02	Conc (mol)	4,92E-11	3,97E-02	1,22E-02	5,31E-03	4,06E-07	3,31E-04	4,18E-03	8,33E-05	5,55E-03
		Activity	4,01E-11	3,24E-02	5,39E-03	4,33E-03	4,11E-07	2,70E-04	3,41E-03	8,43E-05	4,53E-03
		Gamma	8,15E-01	8,16E-01	4,42E-01	8,15E-01	1,01E+00	8,15E-01	8,16E-01	1,01E+00	8,16E-01
11,0	5,42E-02	Conc (mol)	1,23E-11	3,89E-02	1,52E-02	4,69E-04	3,11E-08	1,33E-03	5,04E-03	2,50E-05	1,71E-03
		Activity	1,00E-11	3,16E-02	6,65E-03	3,81E-04	3,15E-08	1,08E-03	4,10E-03	2,53E-05	1,39E-03
		Gamma	8,13E-01	8,13E-01	4,37E-01	8,13E-01	1,01E+00	8,13E-01	8,13E-01	1,01E+00	8,13E-01

Table A7-11
Speciation Modeling of Experiment 7

Feed	10 g/l Na as sodium carbonate
Initial solution pH	11,3

Feed pH	Ionic strength (m)	Parameter	Speciation H^+ (m)	Na^+ (m)	$CO_3^{=}$ (m)	NO_3^- (m)	H_2CO_3 (m)	OH^- (m)	$NaCO_3^-$ (m)	$NaHCO_3$ (m)	HCO_3^- (m)
7,2	4,14E-01	Conc (mol)	9,19E-08	4,14E-01	3,70E-04	2,33E-01	1,70E-02	2,30E-07	7,53E-04	1,95E-02	1,79E-01
		Activity	6,51E-08	2,93E-01	9,33E-05	1,65E-01	1,87E-02	1,63E-07	5,33E-04	2,14E-02	1,27E-01
		Gamma	7,09E-01	7,09E-01	2,52E-01	0,70876	1,10E+00	7,09E-01	7,09E-01	1,10E+00	7,09E-01
8,3	4,99E-01	Conc (mol)	7,13E-09	4,05E-01	4,82E-03	2,04E-01	1,34E-03	2,97E-06	9,62E-03	1,94E-02	1,82E-01
		Activity	5,06E-09	2,87E-01	1,22E-03	1,45E-01	1,47E-03	2,10E-06	6,82E-03	2,13E-02	1,29E-01
		Gamma	7,09E-01	7,09E-01	2,53E-01	7,09E-01	1,10E+00	7,09E-01	7,09E-01	1,10E+00	7,09E-01
9,0	4,20E-01	Conc (mol)	1,42E-09	3,83E-01	1,94E-02	1,61E-01	2,16E-04	1,49E-05	3,66E-02	1,47E-02	1,46E-01
		Activity	1,01E-09	2,71E-01	4,91E-03	1,14E-01	2,36E-04	1,06E-05	2,60E-02	1,61E-02	1,04E-01
		Gamma	7,09E-01	7,09E-01	2,53E-01	7,09E-01	1,10E+00	7,09E-01	7,09E-01	1,10E+00	7,09E-01
9,6	3,93E-01	Conc (mol)	3,56E-10	3,48E-01	4,54E-02	9,35E-02	3,17E-05	5,96E-05	7,81E-02	7,88E-03	8,57E-02
		Activity	2,52E-10	2,47E-01	1,15E-02	6,64E-02	3,47E-05	4,23E-05	5,54E-02	8,62E-03	6,08E-02
		Gamma	7,10E-01	7,10E-01	2,54E-01	7,10E-01	1,09E+00	7,10E-01	7,10E-01	1,09E+00	7,10E-01
10,6	3,90E-01	Conc (mol)	3,54E-11	3,11E-01	7,91E-02	1,55E-02	5,50E-07	6,00E-04	1,22E-01	1,23E-03	1,49E-02
		Activity	2,51E-11	2,21E-01	2,01E-02	1,10E-02	6,02E-07	4,26E-04	8,65E-02	1,34E-03	1,06E-02
		Gamma	7,10E-01	7,10E-01	2,54E-01	7,10E-01	1,09E+00	7,10E-01	7,10E-01	1,09E+00	7,10E-01
11,3	3,90E-01	Conc (mol)	7,06E-12	3,05E-01	8,51E-02	4,39E-04	2,35E-08	3,01E-03	1,29E-01	2,58E-04	3,19E-03
		Activity	5,01E-12	2,17E-01	2,16E-02	3,12E-04	2,57E-08	2,14E-03	9,12E-02	2,82E-04	2,27E-03
		Gamma	7,10E-01	7,10E-01	2,54E-01	7,10E-01	1,09E+00	7,10E-01	7,10E-01	1,09403	7,10E-01

Table A7-12
Speciation Modeling of Experiment 8

Feed — 30 g/l Na as sodium carbonate
Initial solution pH — 11,5

Feed pH	Ionic strength (m)	Parameter	Speciation								
			H^+ (m)	Na^+ (m)	$CO_3^=$ (m)	NO_3^- (m)	H_2CO_3 (m)	OH^- (m)	$NaCO_3^-$ (m)	$NaHCO_3$ (m)	HCO_3^- (m)
7,9	1,14E+00	Conc (mol)	1,71E-08	1,14E+00	4,16E-03	6,26E-01	7,98E-03	1,06E-06	2,95E-02	1,35E-01	4,75E-01
		Activity	1,28E-08	8,56E-01	1,33E-03	4,71E-01	1,04E-02	7,98E-07	2,22E-02	1,76E-01	3,57E-01
		Gamma	7,52E-01	7,52E-01	3,19E-01	7,52E-01	1,30E+00	7,52E-01	7,52E-01	1,30E+00	7,52E-01
8,5	1,11E+00	Conc (mol)	4,28E-09	1,09E+00	1,51E-02	5,39E-01	1,77E-03	4,30E-06	9,98E-02	1,14E-01	4,21E-01
		Activity	3,20E-09	8,15E-01	4,70E-03	4,03E-01	2,28E-03	3,21E-06	7,46E-02	1,47E-01	3,15E-01
		Gamma	7,47E-01	7,47E-01	3,12E-01	7,47E-01	1,29E+00	7,47E-01	7,47E-01	1,29E+00	7,47E-01
9,1	1,03E+00	Conc (mol)	1,08E-09	9,86E-01	4,31E-02	3,62E-01	3,06E-04	1,75E-05	2,47E-01	7,09E-02	2,91E-01
		Activity	7,98E-10	7,29E-01	1,29E-02	2,68E-01	3,88E-04	1,29E-05	1,83E-01	8,99E-02	2,15E-01
		Gamma	7,39E-01	7,39E-01	2,98E-01	7,39E-01	1,27E+00	7,39E-01	7,39E-01	1,27E+00	7,39E-01
9,6	9,64E-01	Conc (mol)	3,43E-10	8,87E-01	7,66E-02	1,94E-01	5,30E-05	5,64E-05	3,82E-01	3,48E-02	1,59E-01
		Activity	2,52E-10	6,50E-01	2,21E-02	1,42E-01	6,62E-05	4,13E-05	2,80E-01	4,34E-02	1,16E-01
		Gamma	7,33E-01	7,33E-01	2,88E-01	7,33E-01	1,25E+00	7,33E-01	7,33E-01	1,25E+00	7,33E-01
10,6	9,10E-01	Conc (mol)	3,45E-11	7,93E-01	1,17E-01	2,78E-02	7,95E-07	5,72E-04	5,07E-01	4,63E-03	2,37E-02
		Activity	2,51E-11	5,77E-01	3,28E-02	2,02E-02	9,80E-07	4,17E-04	3,69E-01	5,71E-03	1,72E-02
		Gamma	7,28E-01	7,28E-01	2,80E-01	7,28E-01	1,23E+00	7,28E-01	7,28E-01	1,23E+00	7,28E-01
11,5	9,03E-01	Conc (mol)	5,29E-12	7,79E-01	1,24E-01	8,04E-04	1,96E-08	3,75E-03	5,24E-01	7,34E-04	3,82E-03
		Activity	3,84E-12	5,67E-01	3,45E-02	5,85E-04	2,41E-08	2,72E-03	3,81E-01	9,03E-04	2,78E-03
		Gamma	7,27E-01	7,27E-01	2,79E-01	7,27E-01	1,23E+00	7,27E-01	7,27E-01	1,23E+00	7,27E-01

Table A7-13
Speciation Modeling of Experiment 4

Feed	10 g/l Na as sodium carbonate
	10 mg/l Ca as calcium chloride
	10 mg/l Mg as magnesium hydroxide
Initial solution pH	11,5

Feed pH	Ionic strength (m)	Parameter	Speciation								
			H^+ (m)	Na^+ (m)	$CO_3^=$ (m)	Ca^{++} (m)	Cl^- (m)	Mg^{++} (m)	NO_3^- (m)	H_2CO_3 (m)	OH^- (m)
7,2	4,15E-01	Conc (mol)	9,20E-08	4,14E-01	3,69E-04	1,65E-04	5,00E-04	2,71E-04	2,33E-01	1,70E-02	2,30E-07
		Activity	6,52E-08	2,93E-01	9,30E-05	4,17E-05	3,54E-04	6,84E-05	1,65E-01	1,87E-02	1,63E-07
		Gamma	7,09E-01	7,09E-01	2,52E-01	2,52E-01	7,09E-01	2,52E-01	7,09E-01	1,10E+00	7,09E-01
8,2	4,11E-01	Conc (mol)	8,99E-09	4,07E-01	3,87E-03	1,37E-04	5,00E-04	2,39E-04	2,07E-01	1,71E-03	2,36E-06
		Activity	6,37E-09	2,88E-01	9,77E-04	3,46E-05	3,54E-04	6,02E-05	1,47E-01	1,88E-03	1,67E-06
		Gamma	7,09E-01	7,09E-01	2,53E-01	2,53E-01	7,09E-01	2,53E-01	7,09E-01	1,10E+00	7,09E-01
9,0	4,03E-01	Conc (mol)	1,42E-09	3,83E-01	1,94E-02	8,22E-05	5,00E-04	1,66E-04	1,61E-01	2,15E-04	1,49E-05
		Activity	1,01E-09	2,71E-01	4,91E-03	2,08E-05	3,55E-04	4,20E-05	1,14E-01	2,35E-04	1,06E-05
		Gamma	7,09E-01	7,09E-01	2,53E-01	2,53E-01	7,09E-01	2,53E-01	7,09E-01	1,10E+00	7,09E-01
10,0	3,91E-01	Conc (mol)	1,41E-10	3,28E-01	6,30E-02	3,83E-05	5,00E-04	8,86E-05	5,12E-02	6,95E-06	1,50E-04
		Activity	1,00E-10	2,33E-01	1,60E-02	9,73E-06	3,55E-04	2,25E-05	3,64E-02	7,61E-06	1,07E-04
		Gamma	7,10E-01	7,10E-01	2,54E-01	2,54E-01	7,10E-01	2,54E-01	7,10E-01	1,09E+00	7,10E-01
11,0	3,90E-01	Conc (mol)	6,61E-12	3,05E-01	8,49E-02	3,01E-05	5,00E-04	7,01E-05	1,41E-11	2,06E-08	3,22E-03
		Activity	4,69E-12	2,17E-01	2,16E-02	7,64E-06	3,55E-04	1,78E-05	9,99E-12	2,25E-08	2,28E-03
		Gamma	7,10E-01	7,10E-01	2,54E-01	2,54E-01	7,10E-01	2,54E-01	7,10E-01	1,09E+00	7,10E-01

Table A7-13 continued
Speciation Modeling of Experiment 4

Feed pH	Parameter	Speciation								
		$MgOH^+$ (m)	$MgCO_3$ (m)	$MgHCO_3^+$ (m)	$CaOH^+$ (m)	$CaHCO_3^+$ (m)	$CaCO_3$ (m)	$NaCO_3^-$ (m)	$NaHCO_3$ (m)	HCO_3^- (m)
7,2	Conc (mol)	2,60E-09	5,60E-06	1,43E-04	2,42E-10	7,98E-05	5,12E-06	7,50E-04	1,94E-02	1,79E-01
	Activity	1,84E-09	6,17E-06	1,02E-04	1,72E-10	5,65E-05	5,64E-06	5,32E-04	2,14E-02	1,27E-01
	Gamma	7,09E-01	1,10E+00	7,09E-01	7,09E-01	7,09E-01	1,10E+00	7,09E-01	1,10E+00	7,09E-01
8,2	Conc (mol)	2,35E-08	5,19E-05	1,30E-04	2,06E-09	6,80E-05	4,48E-05	7,74E-03	1,96E-02	1,84E-01
	Activity	1,67E-08	5,70E-05	9,18E-05	1,46E-09	4,82E-05	4,92E-05	5,49E-03	2,16E-02	1,30E-01
	Gamma	7,09E-01	1,10E+00	7,09E-01	7,09E-01	7,09E-01	1,10E+00	7,09E-01	1,10E+00	7,09E-01
9,0	Conc (mol)	1,04E-07	1,82E-04	7,17E-05	7,85E-09	3,24E-05	1,35E-04	3,66E-02	1,47E-02	1,46E-01
	Activity	7,37E-08	2,00E-04	5,08E-05	5,57E-09	2,30E-05	1,48E-04	2,60E-02	1,61E-02	1,03E-01
	Gamma	7,09E-01	1,10E+00	7,09E-01	7,09E-01	7,09E-01	1,10E+00	7,09E-01	1,10E+00	7,09E-01
10,0	Conc (mol)	5,60E-07	3,18E-04	1,24E-05	3,70E-08	4,91E-06	2,07E-04	1,02E-01	4,10E-03	4,73E-02
	Activity	3,97E-07	3,48E-04	8,82E-06	2,62E-08	3,49E-06	2,26E-04	7,25E-02	4,48E-03	3,35E-02
	Gamma	7,10E-01	1,09E+00	7,10E-01	7,10E-01	7,10E-01	1,09E+00	7,10E-01	1,09E+00	7,10E-01
11,0	Conc (mol)	9,47E-06	3,40E-04	6,21E-08	6,22E-07	2,44E-07	2,19E-04	1,28E-01	2,41E-04	2,98E-03
	Activity	6,73E-06	3,72E-04	4,41E-08	4,41E-07	1,73E-07	2,40E-04	9,11E-02	2,64E-04	2,12E-03
	Gamma	7,10E-01	1,09E+00	7,10E-01	7,10E-01	7,10E-01	1,09E+00	7,10E-01	1,09E+00	7,10E-01

Table A7-14
Speciation Modeling of Experiment 5

Feed	10 g/l Na as sodium carbonate 10 mg/l Ca as calcium chloride 10 mg/l Mg as magnesium hydroxide 100 mg/l EDTA
Initial solution pH	11,5

Feed pH	Ionic strength (m)	Parameter	Species H^+ (m)	Na^+ (m)	$CO_3^{=}$ (m)	Ca^{++} (m)	Cl^- (m)	Mg^{++} (m)	$EDTA^{4-}$ (m)	NO_3^- (m)	Na EDTA (m)
7,2	4,16E-01	Conc (mol)	1,28E-07	4,15E-01	2,58E-04	7,78E-06	5,00E-04	2,09E-04	3,01E-09	2,39E-01	2,51E-08
		Activity	9,06E-08	2,94E-01	6,51E-05	1,96E-06	3,54E-04	5,26E-05	1,22E-11	1,70E-01	1,13E-09
		Gamma	7,09E-01	7,09E-01	2,52E-01	2,52E-01	7,09E-01	2,52E-01	4,05E-03	7,09E-01	4,51E-02
7,8	4,14E-01	Conc (mol)	2,28E-08	4,11E-01	1,56E-03	7,20E-06	5,00E-04	1,94E-04	3,25E-09	2,17E-01	2,69E-08
		Activity	1,62E-08	2,91E-01	3,93E-04	1,82E-06	3,54E-04	4,89E-05	1,32E-11	1,54E-01	1,21E-09
		Gamma	7,09E-01	7,09E-01	2,52E-01	2,52E-01	7,09E-01	2,52E-01	4,06E-03	7,09E-01	4,52E-02
9,0	4,03E-01	Conc (mol)	1,42E-09	3,83E-01	1,94E-02	4,52E-06	5,00E-04	1,25E-04	5,08E-09	1,61E-01	3,94E-08
		Activity	1,01E-09	2,71E-01	4,90E-03	1,14E-06	3,55E-04	3,17E-05	2,26E-09	1,14E-01	1,79E-09
		Gamma	7,09E-01	7,09E-01	2,53E-01	2,53E-01	7,09E-01	2,53E-01	4,44E-01	7,09E-01	4,54E-02
10,0	3,92E-01	Conc (mol)	1,41E-10	3,28E-01	6,31E-02	2,35E-06	5,00E-04	6,63E-05	9,60E-09	5,13E-02	6,41E-08
		Activity	1,00E-10	2,33E-01	1,60E-02	5,95E-07	3,55E-04	1,68E-05	3,98E-11	3,64E-02	2,93E-09
		Gamma	7,10E-01	7,10E-01	2,54E-01	2,54E-01	7,10E-01	2,54E-01	4,15E-03	7,10E-01	4,57E-02
11,0	3,91E-01	Conc (mol)	1,41E-11	3,07E-01	1,90E-06	5,00E-04	5,39E-05	1,18E-08	8,34E-02	5,24E-03	7,40E-08
		Activity	1,00E-11	2,18E-01	4,82E-07	3,55E-04	1,37E-05	4,91E-11	2,12E-02	3,72E-03	3,39E-09
		Gamma	7,10E-01	7,10E-01	2,54E-01	7,10E-01	2,54E-01	4,15E-03	2,54E-01	7,10E-01	4,58E-02

Table A7-14 continued 1
Speciation Modeling of Experiment 5

Feed pH	Parameter	Speciation								
		OH^- (m)	$MgOH^+$ (m)	$MgCO_3$ (m)	$MgHCO_3^+$ (m)	$CaOH^+$ (m)	$CaHCO_3^+$ (m)	$CaCO_3$ (m)	$NaCO_3^-$ (m)	$NaHCO_3$ (m)
7,2	Conc (mol)	1,66E-07	1,44E-09	3,02E-06	1,07E-04	8,21E-12	3,65E-06	1,69E-07	5,26E-04	1,89E-02
	Activity	1,17E-07	1,02E-09	3,32E-06	7,60E-05	5,82E-12	2,59E-06	1,86E-07	3,73E-04	2,08E-02
	Gamma	7,09E-01	7,09E-01	1,10E+00	7,09E-01	7,09E-01	7,09E-01	1,10E+00	7,09E-01	1,10E+00
7,8	Conc (mol)	9,28E-07	7,52E-09	1,69E-05	1,07E-04	4,26E-11	3,64E-06	9,44E-07	3,15E-03	2,02E-02
	Activity	6,58E-07	5,33E-09	1,86E-05	7,61E-05	3,02E-11	2,58E-06	1,04E-06	2,23E-03	2,22E-02
	Gamma	7,09E-01	7,09E-01	1,10E+00	7,09E-01	7,09E-01	7,09E-01	1,10E+00	7,09E-01	1,10E+00
9,0	Conc (mol)	1,49E-05	7,81E-08	1,37E-04	5,41E-05	4,31E-10	1,78E-06	7,43E-06	3,66E-02	1,47E-02
	Activity	1,06E-05	5,54E-08	1,50E-04	3,83E-05	3,05E-10	1,26E-06	8,15E-06	2,59E-02	1,61E-02
	Gamma	7,09E-01	7,09E-01	1,10E+00	7,09E-01	7,09E-01	7,09E-01	1,10E+00	7,09E-01	1,10E+00
10,0	Conc (mol)	1,50E-04	4,19E-07	2,39E-04	9,32E-06	2,26E-09	3,01E-07	1,27E-05	1,02E-01	4,10E-03
	Activity	1,07E-04	2,97E-07	2,61E-04	6,62E-06	1,60E-09	2,14E-07	1,39E-05	7,25E-02	4,49E-03
	Gamma	7,10E-01	7,10E-01	1,09E+00	7,10E-01	7,10E-01	7,10E-01	1,09E+00	7,10E-01	1,09E+00
11,0	Conc (mol)	1,51E-03	3,42E-06	2,56E-04	9,99E-07	1,84E-08	3,22E-08	1,36E-05	1,27E-01	5,07E-04
	Activity	1,07E-03	2,42E-06	2,80E-04	7,09E-07	1,31E-08	2,28E-08	1,48E-05	8,99E-02	5,54E-04
	Gamma	7,10E-01	7,10E-01	1,09E+00	7,10E-01	7,10E-01	7,10E-01	1,09E+00	7,10E-01	1,09E+00

Table A7-14 continued 2
Speciation Modeling of Experiment 5

Feed pH	Parameter	Speciation										
		HCO_3^- (m)	H_2CO_3 (m)	EDTAH (m)	$EDTAH_2$ (m)	$EDTAH_3$ (m)	EDTAH4 (m)	$EDTAH_5$ (m)	Ca EDTA (m)	CaHEDTA (m)	Mg EDTA (m)	MgHEDTA (m)
7,2	Conc (mol)	1,74E-01	2,30E-02	2,24E-07	6,43E-09	9,26E-14	6,35E-19	3,05E-23	2,38E-04	3,06E-08	1,01E-04	1,03E-07
	Activity	1,23E-01	2,53E-02	1,01E-08	1,62E-09	6,56E-14	6,98E-19	2,16E-23	6,01E-05	2,17E-08	2,55E-05	7,31E-08
	Gamma	7,09E-01	1,10E+00	4,51E-02	2,52E-01	7,09E-01	1,10E+00	7,09E-01	2,52E-01	7,09E-01	2,52E-01	7,09E-01
7,8	Conc (mol)	1,88E-01	4,42E-03	4,30E-08	2,21E-10	5,68E-16	6,96E-22	5,97E-27	2,38E-04	5,46E-09	1,02E-04	1,85E-08
	Activity	1,33E-01	4,86E-03	1,94E-09	5,58E-11	4,03E-16	6,95E-23	4,23E-27	6,01E-05	3,87E-09	2,57E-05	1,31E-08
	Gamma	7,09E-01	1,10E+00	4,52E-02	2,52E-01	7,09E-01	9,99E-02	7,09E-01	2,52E-01	7,09E-01	2,52E-01	7,09E-01
9,0	Conc (mol)	1,46E-01	2,15E-04	4,22E-09	1,36E-12	2,18E-19	1,67E-26	8,91E-33	2,36E-04	3,38E-10	1,04E-04	1,18E-09
	Activity	1,03E-01	2,36E-04	1,91E-10	3,43E-13	1,55E-19	1,83E-26	6,32E-33	5,98E-05	2,40E-10	2,62E-05	8,36E-10
	Gamma	7,09E-01	1,10E+00	4,54E-02	2,53E-01	7,09E-01	1,10E+00	7,09E-01	2,53E-01	7,09E-01	2,53E-01	7,09E-01
10,0	Conc (mol)	4,73E-02	6,96E-06	7,97E-10	2,56E-14	4,10E-22	3,13E-30	1,66E-37	2,35E-04	3,35E-11	1,05E-04	1,19E-10
	Activity	3,36E-02	7,62E-07	3,64E-11	6,50E-15	2,91E-22	3,43E-30	1,17E-37	5,96E-05	2,38E-11	2,67E-05	8,47E-11
	Gamma	7,10E-01	1,09E-01	4,57E-02	2,54E-01	7,10E-01	1,09E+00	7,10E-01	2,54E-01	7,10E-01	2,54E-01	7,10E-01
11,0	Conc (mol)	6,24E-03	9,17E-08	9,81E-11	3,14E-16	5,02E-25	3,83E-34	2,02E-42	2,35E-04	3,34E-12	1,05E-04	1,19E-11
	Activity	4,43E-03	1,00E-07	4,49E-12	7,98E-17	3,56E-25	4,19E-34	1,43E-42	5,95E-05	2,37E-12	2,68E-05	8,47E-12
	Gamma	7,10E-01	1,09E+00	4,58E-02	2,54E-01	7,10E-01	1,09E+00	7,10E-01	2,54E-01	7,10E-01	2,54E-01	7,10E-01

Table A7-15
Osmotic Pressures Predicted from Speciation Data
(using the equation described in Section 5.4.3.3)

Experiment No.	Feed Na (g/l)	pH	Predicted Osmotic Pressure (kPa)		Experimental Osmotic Pressure (kPa)
			20 °C	26 °C	
6	1	11,0	136	139	123
		10,4	147	150	136
		10,0	163	166	157
		9,4	185	189	170
		8,9	195	199	175
		8,1	201	205	175
		6,9	211	216	188
7	10	11,3	1094	1117	1068
		10,6	1139	1163	1137
		9,6	1417	1446	1393
		9,0	1662	1696	1579
		8,3	1816	1853	1670
		7,2	1906	1945	1701
8	30	11,5	3101	3165	2902
		10,6	3190	3255	3047
		9,6	3807	3885	3726
		9,1	4441	4532	4080
		8,5	5108	5212	4556
		7,9	5432	5543	4658

Calculated Values for Various Parameters Used in Membrane Performance Evaluation

Table A7-16
Experiment 6: Nanofiltration of Sodium Carbonate Containing 1 g/l Na

pH feed	pH perm	J_W (l/m²h)	$\Delta\pi$ (kPa)	ΔP-$\Delta\pi$ (kPa)	A (l/m²h.kPa)	TIC perm (mol/l)	J_{IC} (mol/m²h)	TIC C_f-C_p (mol/l)	J_{IC}/C_f-C_p (l/m²h)	Na perm (mol/l)	J_{Na} (mol/m²h)	Na C_f-C_p (mol/l)	J_{Na}/C_f-C_p (l/m²h)
11,0	10,9	55,6	116	1184	0,047	0,0013	0,0695	0,0208	3,35	0,0004	0,0203	0,0419	0,48
10,4	10,1	58,4	109	1191	0,049	0,0021	0,1217	0,0200	6,08	0,0067	0,3910	0,0367	10,67
10,0	9,7	69,8	88	1212	0,058	0,0033	0,2327	0,0190	12,25	0,0128	0,8922	0,0305	29,27
9,4	9,2	70,9	84	1216	0,058	0,0046	0,3250	0,0181	17,97	0,0203	1,4396	0,0230	62,47
8,9	8,8	70,9	73	1227	0,058	0,0054	0,3840	0,0167	23,04	0,0237	1,6769	0,0191	87,66
8,1	8,2	62,2	57	1243	0,050	0,0068	0,4250	0,0148	28,82	0,0277	1,7254	0,0157	109,62
6,9	7,1	49,1	61	1239	0,040	0,0063	0,3069	0,0081	37,96	0,0288	1,4132	0,0151	93,40

Table A7-17
Experiment 7: Nanofiltration of Sodium Carbonate Containing 10 g/l Na
Calculated Values for Various Parameters Used in Membrane Performance Evaluation

pH feed	pH perm	J_W (l/m²h)	$\Delta\pi$ (kPa)	ΔP-$\Delta\pi$ (kPa)	A (l/m²h.kPa)	TIC perm (mol/l)	J_{IC} (mol/m²h)	TIC C_f-C_p (mol/l)	J_{IC}/C_f-C_p (l/m²h)	Na perm (mol/l)	J_{Na} (mol/m²h)	Na C_f-C_p (mol/l)	J_{Na}/C_f-C_p (l/m²h)
11,3	11,5	17,3	824	476	0,036	0,0429	0,7425	0,1519	4,89	0,0891	1,5420	0,3326	4,64
10,6	10,0	25,0	731	569	0,044	0,0429	1,0729	0,1603	6,70	0,1243	3,1087	0,2827	10,99
9,6	9,0	33,6	513	787	0,043	0,0750	2,5200	0,1333	18,90	0,2304	7,7426	0,1853	41,77
9,0	8,5	40,9	411	889	0,046	0,0958	3,9196	0,1094	35,82	0,3174	12,9813	0,1017	127,70
8,3	8,1	41,1	361	939	0,044	0,1133	4,6580	0,0982	47,45	0,3543	14,5637	0,0652	223,31
7,2	7,4	41,4	354	946	0,044	0,1104	4,5713	0,0844	54,15	0,3543	14,6700	0,0908	161,59

Table A7-18
Experiment 8: Nanofiltration of Sodium Carbonate Containing 30 g/l Na
Calculated Values for Various Parameters Used in Membrane Performance Evaluation

pH feed	pH perm	J_W (l/m²h)	$\Delta\pi$ (kPa)	ΔP-$\Delta\pi$ (kPa)	A (l/m²h.kPa)	TIC perm (mol/l)	J_{IC} (mol/m²h)	TIC C_f-C_p (mol/l)	J_{IC}/C_f-C_p (l/m²h)	Na perm (mol/l)	J_{Na} (mol/m²h)	Na C_f-C_p (mol/l)	J_{Na}/C_f-C_p (l/m²h)
10,6	10,4	3,4	1089	211	0,016	0,3708	1,2608	0,2750	4,58	0,8207	2,7902	0,5707	4,89
9,6	9,6	9,0	1007	293	0,031	0,3542	3,1875	0,2542	12,54	0,8457	7,6109	0,4913	15,49
9,1	9,1	16,7	728	572	0,029	0,3750	6,2625	0,2083	30,06	0,9533	15,9195	0,3511	45,34
8,5	8,5	25,5	783	517	0,049	0,3354	8,5531	0,2625	32,58	0,9946	25,3614	0,3424	74,07
7,9	7,9	27,8	815	485	0,057	0,3354	9,3246	0,2271	41,06	1,0543	29,3109	0,2609	112,36

Condensed Output Files from MINTEQA2 Modeling

Run 1: 1 g/l Na, change pH with nitric acid

Run 2: 10 g.l Na, change pH with nitric acid

Run 3: 30 g.l Na, change pH with nitric acid

Run 4: 10 g/l Na, 10 mg/l Ca, 10 mg/l Mg, change pH with nitric acid

Run 5: 10 g/l Na, 10 mg/l Ca, 10 mg/l Mg, EDTA, change pH with nitric acid

Run 4: 10 g/l Na, 10 mg/l Ca, 10 mg/l Mg, change pH with nitric acid, allow precipitation

Run 5: 10 g/l Na, 10 mg/l Ca, 10 mg/l Mg, change pH with nitric acid, allow precipitation

PC MINTEQA2 v3.10   DATE OF CALCULATIONS: 25-AUG-94   TIME: 14:53:42

Run 1 - 1 g/l Na; sample 1; pH 11.0
add HNO3

Type I - COMPONENTS AS SPECIES IN SOLUTION

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
330	H+1	1.231E-11	1.000E-11	-10.99981	0.81293	0.090
500	Na+1	3.893E-02	3.165E-02	-1.49965	0.81293	0.090
140	CO3-2	1.522E-02	6.647E-03	-2.17740	0.43673	0.360
492	NO3-1	4.069E-04	3.308E-04	-3.48046	0.81293	0.090

Type II - OTHER SPECIES IN SOLUTION OR ADSORBED

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
3301401	H2CO3 AQ	3.112E-08	3.151E-08	-7.50153	1.01255	16.670
3300020	OH-	1.330E-03	1.081E-03	-2.96598	0.81293	-13.875
5001400	NaCO3 -	5.044E-03	4.100E-03	-2.38721	0.81293	1.380
5001401	NaHCO3 AQ	2.499E-05	2.530E-05	-4.59686	1.01255	10.075
3301400	HCO3 -	1.712E-03	1.392E-03	-2.85639	0.81293	10.411

Type III - SPECIES WITH FIXED ACTIVITY

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
2	H2O	-1.330E-03	-2.876	0.000	0.000

Type VI - EXCLUDED SPECIES (not included in mole balance)

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
3301403	CO2 (g)	9.598E-07	-6.018	18.159	-0.530

PERCENTAGE DISTRIBUTION OF COMPONENTS AMONG
TYPE I and TYPE II (dissolved and adsorbed) species

H+1

6.1	PERCENT BOUND IN SPECIES #5001401	NaHCO3 AQ
420.8	PERCENT BOUND IN SPECIES #3301400	HCO3 -

Na+1

88.5	PERCENT BOUND IN SPECIES # 500	Na+1
11.5	PERCENT BOUND IN SPECIES #5001400	NaCO3 -

CO3-2

69.2	PERCENT BOUND IN SPECIES # 140	CO3-2
22.9	PERCENT BOUND IN SPECIES #5001400	NaCO3 -
7.8	PERCENT BOUND IN SPECIES #3301400	HCO3 -

NO3-1

100.0	PERCENT BOUND IN SPECIES # 492	NO3-1

H2O

100.0	PERCENT BOUND IN SPECIES #3300020	OH-

----------- EQUILIBRATED MASS DISTRIBUTION -----------

IDX	NAME	DISSOLVED		SORBED		PRECIPITATED	
		MOL/KG	PERCENT	MOL/KG	PERCENT	MOL/KG	PERCENT
330	H+1	4.069E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
500	Na+1	4.400E-02	100.0	0.000E-01	0.0	0.000E-01	0.0
140	CO3-2	2.200E-02	100.0	0.000E-01	0.0	0.000E-01	0.0
492	NO3-1	4.069E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
2	H2O	1.330E-03	100.0	0.000E-01	0.0	0.000E-01	0.0

Charge Balance: SPECIATED

Sum of CATIONS = 3.893E-02 Sum of ANIONS 3.893E-02

PERCENT DIFFERENCE = 4.538E-04 (ANIONS - CATIONS)/(ANIONS + CATIONS)

EQUILIBRIUM IONIC STRENGTH (m) = 5.415E-02

EQUILIBRIUM pH = 11.000

DATE ID NUMBER: 940902
TIME ID NUMBER: 14141372

Run 1 - 1 g/l Na; sample 2; pH 10,4
add HNO3

Type I - COMPONENTS AS SPECIES IN SOLUTION

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
330	H+1	4.921E-11	4.013E-11	-10.39654	0.81547	0.089
500	Na+1	3.974E-02	3.241E-02	-1.48937	0.81547	0.089
140	CO3-2	1.219E-02	5.390E-03	-2.26839	0.44221	0.354
492	NO3-1	5.306E-03	4.327E-03	-2.36385	0.81547	0.089

Type II - OTHER SPECIES IN SOLUTION OR ADSORBED

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
3301401	H2CO3 AQ	4.063E-07	4.112E-07	-6.38597	1.01203	16.670
3300020	OH-	3.306E-04	2.696E-04	-3.56933	0.81547	-13.877
5001400	NaCO3 -	4.175E-03	3.405E-03	-2.46792	0.81547	1.378
5001401	NaHCO3 AQ	8.327E-05	8.428E-05	-4.07430	1.01203	10.075
3301400	HCO3 -	5.552E-03	4.528E-03	-2.34411	0.81547	10.409

Type III - SPECIES WITH FIXED ACTIVITY

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
2	H2O	-3.306E-04	-3.481	0.001	0.000

Type VI - EXCLUDED SPECIES (not included in mole balance)

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
3301403	CO2 (g)	1.253E-05	-4.902	18.159	-0.530

PERCENTAGE DISTRIBUTION OF COMPONENTS AMONG
TYPE I and TYPE II (dissolved and adsorbed) species

H+1

1.6	PERCENT BOUND IN SPECIES #5001401	NaHCO3 AQ
104.6	PERCENT BOUND IN SPECIES #3301400	HCO3 -

Na+1

90.3	PERCENT BOUND IN SPECIES # 500	Na+1
9.5	PERCENT BOUND IN SPECIES #5001400	NaCO3 -

CO3-2

55.4	PERCENT BOUND IN SPECIES # 140	CO3-2
19.0	PERCENT BOUND IN SPECIES #5001400	NaCO3 -
25.2	PERCENT BOUND IN SPECIES #3301400	HCO3 -

NO3-1

100.0	PERCENT BOUND IN SPECIES # 492	NO3-1

H2O

100.0	PERCENT BOUND IN SPECIES #3300020	OH-

----------- EQUILIBRATED MASS DISTRIBUTION -----------

IDX	NAME	DISSOLVED		SORBED		PRECIPITATED	
		MOL/KG	PERCENT	MOL/KG	PERCENT	MOL/KG	PERCENT
330	H+1	5.306E-03	100.0	0.000E-01	0.0	0.000E-01	0.0
500	Na+1	4.400E-02	100.0	0.000E-01	0.0	0.000E-01	0.0
140	CO3-2	2.200E-02	100.0	0.000E-01	0.0	0.000E-01	0.0
492	NO3-1	5.306E-03	100.0	0.000E-01	0.0	0.000E-01	0.0
2	H2O	3.306E-04	100.0	0.000E-01	0.0	0.000E-01	0.0

Charge Balance: SPECIATED

Sum of CATIONS = 3.974E-02 Sum of ANIONS 3.974E-02

PERCENT DIFFERENCE = 3.693E-03 (ANIONS - CATIONS)/(ANIONS + CATIONS)

EQUILIBRIUM IONIC STRENGTH (m) = 5.194E-02

EQUILIBRIUM pH = 10.397

DATE ID NUMBER: 940825
TIME ID NUMBER: 15383461

Run 1 - 1 g/l Na; sample 3; pH 10,0
add HNO3

Type I - COMPONENTS AS SPECIES IN SOLUTION

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
330	H+1	1.242E-10	1.017E-10	-9.99288	0.81848	0.087
500	Na+1	4.076E-02	3.336E-02	-1.47677	0.81848	0.087
140	CO3-2	8.657E-03	3.885E-03	-2.41061	0.44878	0.348
492	NO3-1	1.013E-02	8.291E-03	-2.08137	0.81848	0.087

Type II - OTHER SPECIES IN SOLUTION OR ADSORBED

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
3301401	H2CO3 AQ	1.880E-06	1.902E-06	-5.72088	1.01144	16.671
3300020	OH-	1.300E-04	1.064E-04	-3.97306	0.81848	-13.878
5001400	NaCO3 -	3.086E-03	2.526E-03	-2.59756	0.81848	1.377
5001401	NaHCO3 AQ	1.566E-04	1.584E-04	-3.80027	1.01144	10.075
3301400	HCO3 -	1.010E-02	8.267E-03	-2.08268	0.81848	10.408

Type III - SPECIES WITH FIXED ACTIVITY

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
2	H2O	-1.300E-04	-3.886	0.001	0.000

Type VI - EXCLUDED SPECIES (not included in mole balance)

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
3301403	CO2 (g)	5.794E-05	-4.237	18.159	-0.530

PERCENTAGE DISTRIBUTION OF COMPONENTS AMONG
TYPE I and TYPE II (dissolved and adsorbed) species

H+1

1.5 PERCENT BOUND IN SPECIES #5001401 NaHCO3 AQ

99.7 PERCENT BOUND IN SPECIES #3301400 HCO3 -

Na+1

92.6 PERCENT BOUND IN SPECIES # 500 Na+1

7.0 PERCENT BOUND IN SPECIES #5001400 NaCO3 -

CO3-2

39.3 PERCENT BOUND IN SPECIES # 140 CO3-2

14.0 PERCENT BOUND IN SPECIES #5001400 NaCO3 -

45.9 PERCENT BOUND IN SPECIES #3301400 HCO3 -

NO3-1

100.0 PERCENT BOUND IN SPECIES # 492 NO3-1

H2O

100.0 PERCENT BOUND IN SPECIES #3300020 OH-

----------- EQUILIBRATED MASS DISTRIBUTION -----------

IDX	NAME	DISSOLVED		SORBED		PRECIPITATED	
		MOL/KG	PERCENT	MOL/KG	PERCENT	MOL/KG	PERCENT
330	H+1	1.013E-02	100.0	0.000E-01	0.0	0.000E-01	0.0
500	Na+1	4.400E-02	100.0	0.000E-01	0.0	0.000E-01	0.0
140	CO3-2	2.200E-02	100.0	0.000E-01	0.0	0.000E-01	0.0
492	NO3-1	1.013E-02	100.0	0.000E-01	0.0	0.000E-01	0.0
2	H2O	1.300E-04	100.0	0.000E-01	0.0	0.000E-01	0.0

Charge Balance: SPECIATED

Sum of CATIONS = 4.076E-02 Sum of ANIONS 4.076E-02

PERCENT DIFFERENCE = 1.667E-03 (ANIONS - CATIONS)/(ANIONS + CATIONS)

EQUILIBRIUM IONIC STRENGTH (m) = 4.941E-02

EQUILIBRIUM pH = 9.993

DATE ID NUMBER: 940825
TIME ID NUMBER: 15364657

Run 1 - 1 g/l Na; sample 4; pH 9,4
add HNO3

Type I - COMPONENTS AS SPECIES IN SOLUTION

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
330	H+1	4.981E-10	4.098E-10	-9.38738	0.82289	0.085
500	Na+1	4.239E-02	3.488E-02	-1.45740	0.82289	0.085
140	CO3-2	3.525E-03	1.616E-03	-2.79144	0.45853	0.339
492	NO3-1	1.712E-02	1.409E-02	-1.85115	0.82289	0.085

Type II - OTHER SPECIES IN SOLUTION OR ADSORBED

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
3301401	H2CO3 AQ	1.273E-05	1.286E-05	-4.89072	1.01063	16.671
3300020	OH-	3.206E-05	2.638E-05	-4.57866	0.82289	-13.881
5001400	NaCO3 -	1.336E-03	1.099E-03	-2.95900	0.82289	1.374
5001401	NaHCO3 AQ	2.749E-04	2.778E-04	-3.55622	1.01063	10.075
3301400	HCO3 -	1.685E-02	1.387E-02	-1.85801	0.82289	10.405

Type III - SPECIES WITH FIXED ACTIVITY

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
2	H2O	-3.206E-05	-4.494	0.001	0.000

Type VI - EXCLUDED SPECIES (not included in mole balance)

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
3301403	CO2 (g)	3.920E-04	-3.407	18.159	-0.530

PERCENTAGE DISTRIBUTION OF COMPONENTS AMONG
TYPE I and TYPE II (dissolved and adsorbed) species

H+1

1.6	PERCENT BOUND IN SPECIES	#5001401	NaHCO3 AQ
98.4	PERCENT BOUND IN SPECIES	#3301400	HCO3 -

Na+1

96.3	PERCENT BOUND IN SPECIES	# 500	Na+1
3.0	PERCENT BOUND IN SPECIES	#5001400	NaCO3 -

CO3-2

16.0	PERCENT BOUND IN SPECIES	# 140	CO3-2
6.1	PERCENT BOUND IN SPECIES	#5001400	NaCO3 -
1.2	PERCENT BOUND IN SPECIES	#5001401	NaHCO3 AQ
76.6	PERCENT BOUND IN SPECIES	#3301400	HCO3 -

NO3-1

100.0	PERCENT BOUND IN SPECIES	# 492	NO3-1

H2O

100.0	PERCENT BOUND IN SPECIES	#3300020	OH-

----------- EQUILIBRATED MASS DISTRIBUTION -----------

IDX	NAME	DISSOLVED		SORBED		PRECIPITATED	
		MOL/KG	PERCENT	MOL/KG	PERCENT	MOL/KG	PERCENT
330	H+1	1.712E-02	100.0	0.000E-01	0.0	0.000E-01	0.0
500	Na+1	4.400E-02	100.0	0.000E-01	0.0	0.000E-01	0.0
140	CO3-2	2.200E-02	100.0	0.000E-01	0.0	0.000E-01	0.0
492	NO3-1	1.712E-02	100.0	0.000E-01	0.0	0.000E-01	0.0
2	H2O	3.206E-05	100.0	0.000E-01	0.0	0.000E-01	0.0

Charge Balance: SPECIATED

Sum of CATIONS = 4.239E-02 Sum of ANIONS 4.239E-02

PERCENT DIFFERENCE = 2.120E-04 (ANIONS - CATIONS)/(ANIONS + CATIONS)

EQUILIBRIUM IONIC STRENGTH (m) = 4.591E-02

EQUILIBRIUM pH = 9.387

DATE ID NUMBER: 940825
TIME ID NUMBER: 15341789

Run 1 - 1 g/l Na; sample 5; pH 8,9
add HNO3

Type I - COMPONENTS AS SPECIES IN SOLUTION

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
330	H+1	1.582E-09	1.304E-09	-8.88457	0.82481	0.084
500	Na+1	4.316E-02	3.560E-02	-1.44853	0.82481	0.084
140	CO3-2	1.294E-03	5.988E-04	-3.22274	0.46283	0.335
492	NO3-1	2.024E-02	1.669E-02	-1.77745	0.82481	0.084

Type II - OTHER SPECIES IN SOLUTION OR ADSORBED

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
3301401	H2CO3 AQ	4.777E-05	4.826E-05	-4.31638	1.01029	16.671
3300020	OH-	1.005E-05	8.289E-06	-5.08152	0.82481	-13.882
5001400	NaCO3 -	5.037E-04	4.155E-04	-3.38144	0.82481	1.373
5001401	NaHCO3 AQ	3.309E-04	3.343E-04	-3.47584	1.01029	10.076
3301400	HCO3 -	1.982E-02	1.635E-02	-1.78649	0.82481	10.404

Type III - SPECIES WITH FIXED ACTIVITY

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
2	H2O	-1.005E-05	-4.998	0.001	0.000

Type VI - EXCLUDED SPECIES (not included in mole balance)

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
3301403	CO2 (g)	1.471E-03	-2.832	18.159	-0.530

PERCENTAGE DISTRIBUTION OF COMPONENTS AMONG
TYPE I and TYPE II (dissolved and adsorbed) species

H+1

1.6	PERCENT BOUND IN SPECIES #5001401		NaHCO3 AQ
97.9	PERCENT BOUND IN SPECIES #3301400		HCO3 -

Na+1

98.1	PERCENT BOUND IN SPECIES #	500	Na+1
1.1	PERCENT BOUND IN SPECIES #5001400		NaCO3 -

CO3-2

5.9	PERCENT BOUND IN SPECIES #	140	CO3-2
2.3	PERCENT BOUND IN SPECIES #5001400		NaCO3 -
1.5	PERCENT BOUND IN SPECIES #5001401		NaHCO3 AQ
90.1	PERCENT BOUND IN SPECIES #3301400		HCO3 -

NO3-1

100.0	PERCENT BOUND IN SPECIES #	492	NO3-1

H2O

100.0 PERCENT BOUND IN SPECIES #3300020 OH-

----------- EQUILIBRATED MASS DISTRIBUTION -----------

IDX	NAME	DISSOLVED		SORBED		PRECIPITATED	
		MOL/KG	PERCENT	MOL/KG	PERCENT	MOL/KG	PERCENT
330	H+1	2.024E-02	100.0	0.000E-01	0.0	0.000E-01	0.0
500	Na+1	4.400E-02	100.0	0.000E-01	0.0	0.000E-01	0.0
140	CO3-2	2.200E-02	100.0	0.000E-01	0.0	0.000E-01	0.0
492	NO3-1	2.024E-02	100.0	0.000E-01	0.0	0.000E-01	0.0
2	H2O	1.005E-05	100.0	0.000E-01	0.0	0.000E-01	0.0

Charge Balance: SPECIATED

Sum of CATIONS = 4.316E-02 Sum of ANIONS 4.316E-02

PERCENT DIFFERENCE = 9.122E-04 (ANIONS - CATIONS)/(ANIONS + CATIONS)

EQUILIBRIUM IONIC STRENGTH (m) = 4.446E-02

EQUILIBRIUM pH = 8.885

DATE ID NUMBER: 940825
TIME ID NUMBER: 15321343

Run 1 - 1 g/l Na; sample 6; pH 8,1
add HNO3

Type I - COMPONENTS AS SPECIES IN SOLUTION

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
330	H+1	9.869E-09	8.149E-09	-8.08891	0.82573	0.083
500	Na+1	4.356E-02	3.597E-02	-1.44408	0.82573	0.083
140	CO3-2	2.189E-04	1.018E-04	-3.99238	0.46489	0.333
492	NO3-1	2.201E-02	1.817E-02	-1.74054	0.82573	0.083

Type II - OTHER SPECIES IN SOLUTION OR ADSORBED

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
3301401	H2CO3 AQ	3.169E-04	3.201E-04	-3.49469	1.01013	16.671
3300020	OH-	1.607E-06	1.327E-06	-5.87721	0.82573	-13.882
5001400	NaCO3 -	8.640E-05	7.135E-05	-4.14663	0.82573	1.373
5001401	NaHCO3 AQ	3.550E-04	3.586E-04	-3.44537	1.01013	10.076
3301400	HCO3 -	2.102E-02	1.736E-02	-1.76047	0.82573	10.404

Type III - SPECIES WITH FIXED ACTIVITY

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
2	H2O	-1.607E-06	-5.794	0.001	0.000

Type VI - EXCLUDED SPECIES (not included in mole balance)

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
3301403	CO2 (g)	9.757E-03	-2.011	18.159	-0.530

PERCENTAGE DISTRIBUTION OF COMPONENTS AMONG
TYPE I and TYPE II (dissolved and adsorbed) species

H+1

2.9 PERCENT BOUND IN SPECIES #3301401 H2CO3 AQ

1.6 PERCENT BOUND IN SPECIES #5001401 NaHCO3 AQ

95.5 PERCENT BOUND IN SPECIES #3301400 HCO3 -

Na+1

99.0 PERCENT BOUND IN SPECIES # 500 Na+1

CO3-2

1.4 PERCENT BOUND IN SPECIES #3301401 H2CO3 AQ

1.6 PERCENT BOUND IN SPECIES #5001401 NaHCO3 AQ

95.6 PERCENT BOUND IN SPECIES #3301400 HCO3 -

NO3-1

100.0 PERCENT BOUND IN SPECIES # 492 NO3-1

H2O

100.0 PERCENT BOUND IN SPECIES #3300020 OH-

----------- EQUILIBRATED MASS DISTRIBUTION -----------

IDX	NAME	DISSOLVED		SORBED		PRECIPITATED	
		MOL/KG	PERCENT	MOL/KG	PERCENT	MOL/KG	PERCENT
330	H+1	2.201E-02	100.0	0.000E-01	0.0	0.000E-01	0.0
500	Na+1	4.400E-02	100.0	0.000E-01	0.0	0.000E-01	0.0
140	CO3-2	2.200E-02	100.0	0.000E-01	0.0	0.000E-01	0.0
492	NO3-1	2.201E-02	100.0	0.000E-01	0.0	0.000E-01	0.0
2	H2O	1.607E-06	100.0	0.000E-01	0.0	0.000E-01	0.0

Charge Balance: SPECIATED

Sum of CATIONS = 4.356E-02 Sum of ANIONS 4.356E-02

PERCENT DIFFERENCE = 1.400E-05 (ANIONS - CATIONS)/(ANIONS + CATIONS)

EQUILIBRIUM IONIC STRENGTH (m) = 4.378E-02

EQUILIBRIUM pH = 8.089

DATE ID NUMBER: 940825
TIME ID NUMBER: 15272693

Run 1 - 1 g/l Na; sample 7; pH 6,9
add HNO3

Type I - COMPONENTS AS SPECIES IN SOLUTION

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
330	H+1	1.566E-07	1.293E-07	-6.88846	0.82582	0.083
500	Na+1	4.370E-02	3.609E-02	-1.44265	0.82582	0.083
140	CO3-2	1.148E-05	5.341E-06	-5.27240	0.46510	0.332
492	NO3-1	2.617E-02	2.161E-02	-1.66532	0.82582	0.083

Type II - OTHER SPECIES IN SOLUTION OR ADSORBED

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
3301401	H2CO3 AQ	4.186E-03	4.228E-03	-2.37383	1.01012	16.671
3300020	OH-	1.013E-07	8.361E-08	-7.07772	0.82582	-13.882
5001400	NaCO3 -	4.549E-06	3.756E-06	-5.42522	0.82582	1.373
5001401	NaHCO3 AQ	2.966E-04	2.996E-04	-3.52352	1.01012	10.076
3301400	HCO3 -	1.750E-02	1.445E-02	-1.84005	0.82582	10.404

Type III - SPECIES WITH FIXED ACTIVITY

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
2	H2O	-1.013E-07	-6.995	0.001	0.000

Type VI - EXCLUDED SPECIES (not included in mole balance)

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
3301403	CO2 (g)	1.289E-01	-0.890	18.159	-0.530

PERCENTAGE DISTRIBUTION OF COMPONENTS AMONG
TYPE I and TYPE II (dissolved and adsorbed) species

H+1

32.0	PERCENT BOUND IN SPECIES	#3301401	H2CO3 AQ
1.1	PERCENT BOUND IN SPECIES	#5001401	NaHCO3 AQ
66.9	PERCENT BOUND IN SPECIES	#3301400	HCO3 -

Na+1

99.3	PERCENT BOUND IN SPECIES	# 500	Na+1

CO3-2

19.0	PERCENT BOUND IN SPECIES	#3301401	H2CO3 AQ
1.3	PERCENT BOUND IN SPECIES	#5001401	NaHCO3 AQ
79.6	PERCENT BOUND IN SPECIES	#3301400	HCO3 -

NO3-1

100.0	PERCENT BOUND IN SPECIES	# 492	NO3-1

H2O

100.0	PERCENT BOUND IN SPECIES	#3300020	OH-

----------- EQUILIBRATED MASS DISTRIBUTION -----------

IDX	NAME	DISSOLVED		SORBED		PRECIPITATED	
		MOL/KG	PERCENT	MOL/KG	PERCENT	MOL/KG	PERCENT
330	H+1	2.617E-02	100.0	0.000E-01	0.0	0.000E-01	0.0
500	Na+1	4.400E-02	100.0	0.000E-01	0.0	0.000E-01	0.0
140	CO3-2	2.200E-02	100.0	0.000E-01	0.0	0.000E-01	0.0
492	NO3-1	2.617E-02	100.0	0.000E-01	0.0	0.000E-01	0.0
2	H2O	1.013E-07	100.0	0.000E-01	0.0	0.000E-01	0.0

Charge Balance: SPECIATED

Sum of CATIONS = 4.370E-02 Sum of ANIONS 4.370E-02

PERCENT DIFFERENCE = 2.778E-05 (ANIONS - CATIONS)/(ANIONS + CATIONS)

EQUILIBRIUM IONIC STRENGTH (m) = 4.371E-02

EQUILIBRIUM pH = 6.888

DATE ID NUMBER: 940825
TIME ID NUMBER: 16043872

PC MINTEQA2 v3.10   DATE OF CALCULATIONS: 2-SEP-94 TIME: 14:38:18

Run 2 - 10 g/l Na; Sample 1; pH 11.3
add HNO3

Type I - COMPONENTS AS SPECIES IN SOLUTION

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
330	H+1	7.060E-12	5.012E-12	-11.29999	0.70986	0.149
500	Na+1	3.052E-01	2.167E-01	-0.66417	0.70986	0.149
140	CO3-2	8.506E-02	2.160E-02	-1.66560	0.25392	0.595
492	NO3-1	4.389E-04	3.116E-04	-3.50646	0.70986	0.149

Type II - OTHER SPECIES IN SOLUTION OR ADSORBED

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
3301401	H2CO3 AQ	2.349E-08	2.570E-08	-7.59009	1.09403	16.636
3300020	OH-	3.011E-03	2.137E-03	-2.67015	0.70986	-13.816
5001400	NaCO3 -	1.285E-01	9.121E-02	-1.03994	0.70986	1.439
5001401	NaHCO3 AQ	2.578E-04	2.820E-04	-3.54977	1.09403	10.041
3301400	HCO3 -	3.192E-03	2.266E-03	-2.64478	0.70986	10.470

Type III - SPECIES WITH FIXED ACTIVITY

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
2	H2O	-3.011E-03	-2.521	0.005	0.000

Type VI - EXCLUDED SPECIES (not included in mole balance)

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
3301403	CO2 (g)	7.906E-07	-6.102	18.159	-0.530

PERCENTAGE DISTRIBUTION OF COMPONENTS AMONG
TYPE I and TYPE II (dissolved and adsorbed) species

H+1
58.7 PERCENT BOUND IN SPECIES #5001401 NaHCO3 AQ

727.2 PERCENT BOUND IN SPECIES #3301400 HCO3 -

Na+1
70.3 PERCENT BOUND IN SPECIES # 500 Na+1

29.6 PERCENT BOUND IN SPECIES #5001400 NaCO3 -

CO3-2
39.2 PERCENT BOUND IN SPECIES # 140 CO3-2

59.2 PERCENT BOUND IN SPECIES #5001400 NaCO3 -

1.5 PERCENT BOUND IN SPECIES #3301400 HCO3 -

NO3-1
100.0 PERCENT BOUND IN SPECIES # 492 NO3-1

H2O
100.0 PERCENT BOUND IN SPECIES #3300020 OH-

----------- EQUILIBRATED MASS DISTRIBUTION -----------

IDX	NAME	DISSOLVED		SORBED		PRECIPITATED	
		MOL/KG	PERCENT	MOL/KG	PERCENT	MOL/KG	PERCENT
330	H+1	4.389E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
500	Na+1	4.340E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
140	CO3-2	2.170E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
492	NO3-1	4.389E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
2	H2O	3.011E-03	100.0	0.000E-01	0.0	0.000E-01	0.0

Charge Balance: SPECIATED

Sum of CATIONS = 3.052E-01 Sum of ANIONS 3.052E-01

PERCENT DIFFERENCE = 1.439E-05 (ANIONS - CATIONS)/(ANIONS + CATIONS)

EQUILIBRIUM IONIC STRENGTH (m) = 3.903E-01

EQUILIBRIUM pH = 11.300

DATE ID NUMBER: 940902
TIME ID NUMBER: 14382145

Run 2 - 10 g/l Na; sample 2; pH 10,6
add HNO3

Type I - COMPONENTS AS SPECIES IN SOLUTION

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
330	H+1	3.542E-11	2.514E-11	-10.59959	0.70987	0.149
500	Na+1	3.110E-01	2.208E-01	-0.65605	0.70987	0.149
140	CO3-2	7.911E-02	2.009E-02	-1.69705	0.25394	0.595
492	NO3-1	1.552E-02	1.102E-02	-1.95793	0.70987	0.149

Type II - OTHER SPECIES IN SOLUTION OR ADSORBED

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
3301401	H2CO3 AQ	5.499E-07	6.015E-07	-6.22074	1.09398	16.636
3300020	OH-	5.999E-04	4.258E-04	-3.37078	0.70987	-13.816
5001400	NaCO3 -	1.218E-01	8.644E-02	-1.06327	0.70987	1.439
5001401	NaHCO3 AQ	1.225E-03	1.341E-03	-2.87270	1.09398	10.041
3301400	HCO3 -	1.489E-02	1.057E-02	-1.97583	0.70987	10.470

Type III - SPECIES WITH FIXED ACTIVITY

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
2	H2O	-5.999E-04	-3.222	0.005	0.000

Type VI - EXCLUDED SPECIES (not included in mole balance)

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
3301403	CO2 (g)	1.852E-05	-4.732	18.159	-0.530

PERCENTAGE DISTRIBUTION OF COMPONENTS AMONG
TYPE I and TYPE II (dissolved and adsorbed) species

H+1

7.9 PERCENT BOUND IN SPECIES #5001401 NaHCO3 AQ

96.0 PERCENT BOUND IN SPECIES #3301400 HCO3 -

Na+1

71.7 PERCENT BOUND IN SPECIES # 500 Na+1

28.1 PERCENT BOUND IN SPECIES #5001400 NaCO3 -

CO3-2

36.5 PERCENT BOUND IN SPECIES # 140 CO3-2

56.1 PERCENT BOUND IN SPECIES #5001400 NaCO3 -

6.9 PERCENT BOUND IN SPECIES #3301400 HCO3 -

NO3-1

100.0 PERCENT BOUND IN SPECIES # 492 NO3-1

H2O

100.0 PERCENT BOUND IN SPECIES #3300020 OH-

----------- EQUILIBRATED MASS DISTRIBUTION -----------

IDX	NAME	DISSOLVED		SORBED		PRECIPITATED	
		MOL/KG	PERCENT	MOL/KG	PERCENT	MOL/KG	PERCENT
330	H+1	1.552E-02	100.0	0.000E-01	0.0	0.000E-01	0.0
500	Na+1	4.340E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
140	CO3-2	2.170E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
492	NO3-1	1.552E-02	100.0	0.000E-01	0.0	0.000E-01	0.0
2	H2O	5.999E-04	100.0	0.000E-01	0.0	0.000E-01	0.0

Charge Balance: SPECIATED

Sum of CATIONS = 3.110E-01 Sum of ANIONS 3.110E-01

PERCENT DIFFERENCE = 8.448E-06 (ANIONS - CATIONS)/(ANIONS + CATIONS)

EQUILIBRIUM IONIC STRENGTH (m) = 3.901E-01

EQUILIBRIUM pH = 10.600

DATE ID NUMBER: 940826
TIME ID NUMBER: 9332417

Run 2 - 10 g/l Na; sample 3; pH 9,6
add HNO3

Type I - COMPONENTS AS SPECIES IN SOLUTION

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
330	H+1	3.556E-10	2.524E-10	-9.59797	0.70970	0.149
500	Na+1	3.481E-01	2.470E-01	-0.60728	0.70970	0.149
140	CO3-2	4.536E-02	1.151E-02	-1.93900	0.25369	0.596
492	NO3-1	9.354E-02	6.639E-02	-1.17793	0.70970	0.149

Type II - OTHER SPECIES IN SOLUTION OR ADSORBED

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
3301401	H2CO3 AQ	3.171E-05	3.472E-05	-4.45944	1.09482	16.636
3300020	OH-	5.962E-05	4.231E-05	-4.37357	0.70970	-13.816
5001400	NaCO3 -	7.807E-02	5.541E-02	-1.25644	0.70970	1.439
5001401	NaHCO3 AQ	7.878E-03	8.625E-03	-2.06425	1.09482	10.041
3301400	HCO3 -	8.566E-02	6.079E-02	-1.21615	0.70970	10.470

Type III - SPECIES WITH FIXED ACTIVITY

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
2	H2O	-5.962E-05	-4.225	0.006	0.000

Type VI - EXCLUDED SPECIES (not included in mole balance)

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
3301403	CO2 (g)	1.072E-03	-2.970	18.159	-0.530

PERCENTAGE DISTRIBUTION OF COMPONENTS AMONG
TYPE I and TYPE II (dissolved and adsorbed) species

H+1

8.4 PERCENT BOUND IN SPECIES #5001401 NaHCO3 AQ

91.6 PERCENT BOUND IN SPECIES #3301400 HCO3 -

Na+1

80.2 PERCENT BOUND IN SPECIES # 500 Na+1

18.0 PERCENT BOUND IN SPECIES #5001400 NaCO3 -

1.8 PERCENT BOUND IN SPECIES #5001401 NaHCO3 AQ

CO3-2

20.9 PERCENT BOUND IN SPECIES # 140 CO3-2

36.0 PERCENT BOUND IN SPECIES #5001400 NaCO3 -

3.6 PERCENT BOUND IN SPECIES #5001401 NaHCO3 AQ

39.5 PERCENT BOUND IN SPECIES #3301400 HCO3 -

NO3-1

100.0 PERCENT BOUND IN SPECIES # 492 NO3-1

H2O

100.0 PERCENT BOUND IN SPECIES #3300020 OH-

----------- EQUILIBRATED MASS DISTRIBUTION -----------

IDX	NAME	DISSOLVED		SORBED		PRECIPITATED	
		MOL/KG	PERCENT	MOL/KG	PERCENT	MOL/KG	PERCENT
330	H+1	9.354E-02	100.0	0.000E-01	0.0	0.000E-01	0.0
500	Na+1	4.340E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
140	CO3-2	2.170E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
492	NO3-1	9.354E-02	100.0	0.000E-01	0.0	0.000E-01	0.0
2	H2O	5.962E-05	100.0	0.000E-01	0.0	0.000E-01	0.0

Charge Balance: SPECIATED

Sum of CATIONS = 3.481E-01 Sum of ANIONS 3.481E-01

PERCENT DIFFERENCE = 9.756E-05 (ANIONS - CATIONS)/(ANIONS + CATIONS)

EQUILIBRIUM IONIC STRENGTH (m) = 3.934E-01

EQUILIBRIUM pH = 9.598

DATE ID NUMBER: 940826
TIME ID NUMBER: 9312059

Run 2 - 10 g/l Na; sample 4; pH 9,0
add HNO3

Type I - COMPONENTS AS SPECIES IN SOLUTION

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
330	H+1	1.422E-09	1.008E-09	-8.99642	0.70928	0.149
500	Na+1	3.827E-01	2.714E-01	-0.56633	0.70928	0.149
140	CO3-2	1.940E-02	4.909E-03	-2.30902	0.25309	0.597
492	NO3-1	1.612E-01	1.143E-01	-0.94178	0.70928	0.149

Type II - OTHER SPECIES IN SOLUTION OR ADSORBED

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
3301401	H2CO3 AQ	2.155E-04	2.364E-04	-3.62637	1.09700	16.635
3300020	OH-	1.490E-05	1.057E-05	-4.97613	0.70928	-13.816
5001400	NaCO3 -	3.662E-02	2.597E-02	-1.58551	0.70928	1.439
5001401	NaHCO3 AQ	1.472E-02	1.615E-02	-1.79177	1.09700	10.040
3301400	HCO3 -	1.461E-01	1.036E-01	-0.98463	0.70928	10.470

Type III - SPECIES WITH FIXED ACTIVITY

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
2	H2O	-1.490E-05	-4.827	0.007	0.000

Type VI - EXCLUDED SPECIES (not included in mole balance)

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
3301403	CO2 (g)	7.313E-03	-2.136	18.159	-0.530

PERCENTAGE DISTRIBUTION OF COMPONENTS AMONG
TYPE I and TYPE II (dissolved and adsorbed) species

H+1

9.1 PERCENT BOUND IN SPECIES #5001401 NaHCO3 AQ

90.6 PERCENT BOUND IN SPECIES #3301400 HCO3 -

Na+1

88.2 PERCENT BOUND IN SPECIES # 500 Na+1

8.4 PERCENT BOUND IN SPECIES #5001400 NaCO3 -

3.4 PERCENT BOUND IN SPECIES #5001401 NaHCO3 AQ

CO3-2

8.9 PERCENT BOUND IN SPECIES # 140 CO3-2

16.9 PERCENT BOUND IN SPECIES #5001400 NaCO3 -

6.8 PERCENT BOUND IN SPECIES #5001401 NaHCO3 AQ

67.3 PERCENT BOUND IN SPECIES #3301400 HCO3 -

NO3-1

100.0 PERCENT BOUND IN SPECIES # 492 NO3-1

H2O

100.0 PERCENT BOUND IN SPECIES #3300020 OH-

----------- EQUILIBRATED MASS DISTRIBUTION -----------

IDX	NAME	DISSOLVED		SORBED		PRECIPITATED	
		MOL/KG	PERCENT	MOL/KG	PERCENT	MOL/KG	PERCENT
330	H+1	1.612E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
500	Na+1	4.340E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
140	CO3-2	2.170E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
492	NO3-1	1.612E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
2	H2O	1.490E-05	100.0	0.000E-01	0.0	0.000E-01	0.0

Charge Balance: SPECIATED

Sum of CATIONS = 3.827E-01 Sum of ANIONS 3.827E-01

PERCENT DIFFERENCE = 1.427E-03 (ANIONS - CATIONS)/(ANIONS + CATIONS)

EQUILIBRIUM IONIC STRENGTH (m) = 4.020E-01

EQUILIBRIUM pH = 8.996

DATE ID NUMBER: 940826
TIME ID NUMBER: 9293156

Run 2 - 10 g/l Na; sample 5; pH 8,3
add HNO3

Type I - COMPONENTS AS SPECIES IN SOLUTION

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
330	H+1	7.132E-09	5.056E-09	-8.29617	0.70894	0.149
500	Na+1	4.050E-01	2.871E-01	-0.54189	0.70894	0.149
140	CO3-2	4.823E-03	1.218E-03	-2.91427	0.25260	0.598
492	NO3-1	2.039E-01	1.446E-01	-0.83996	0.70894	0.149

Type II - OTHER SPECIES IN SOLUTION OR ADSORBED

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
3301401	H2CO3 AQ	1.342E-03	1.475E-03	-2.83112	1.09897	16.635
3300020	OH-	2.967E-06	2.104E-06	-5.67702	0.70894	-13.816
5001400	NaCO3 -	9.618E-03	6.818E-03	-2.16633	0.70894	1.439
5001401	NaHCO3 AQ	1.935E-02	2.126E-02	-1.67234	1.09897	10.039
3301400	HCO3 -	1.819E-01	1.289E-01	-0.88963	0.70894	10.470

Type III - SPECIES WITH FIXED ACTIVITY

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
2	H2O	-2.967E-06	-5.528	0.008	0.000

Type VI - EXCLUDED SPECIES (not included in mole balance)

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
3301403	CO2 (g)	4.571E-02	-1.340	18.159	-0.530

PERCENTAGE DISTRIBUTION OF COMPONENTS AMONG
TYPE I and TYPE II (dissolved and adsorbed) species

H+1

1.3	PERCENT BOUND IN SPECIES	#3301401	H2CO3 AQ
9.5	PERCENT BOUND IN SPECIES	#5001401	NaHCO3 AQ
89.2	PERCENT BOUND IN SPECIES	#3301400	HCO3 -

Na+1

93.3	PERCENT BOUND IN SPECIES	# 500	Na+1
2.2	PERCENT BOUND IN SPECIES	#5001400	NaCO3 -
4.5	PERCENT BOUND IN SPECIES	#5001401	NaHCO3 AQ

CO3-2

2.2	PERCENT BOUND IN SPECIES	# 140	CO3-2
4.4	PERCENT BOUND IN SPECIES	#5001400	NaCO3 -
8.9	PERCENT BOUND IN SPECIES	#5001401	NaHCO3 AQ
83.8	PERCENT BOUND IN SPECIES	#3301400	HCO3 -

NO3-1

100.0	PERCENT BOUND IN SPECIES	# 492	NO3-1

H2O

100.0	PERCENT BOUND IN SPECIES	#3300020	OH-

----------- EQUILIBRATED MASS DISTRIBUTION -----------

IDX	NAME	DISSOLVED		SORBED		PRECIPITATED	
		MOL/KG	PERCENT	MOL/KG	PERCENT	MOL/KG	PERCENT
330	H+1	2.039E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
500	Na+1	4.340E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
140	CO3-2	2.170E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
492	NO3-1	2.039E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
2	H2O	2.967E-06	100.0	0.000E-01	0.0	0.000E-01	0.0

Charge Balance: SPECIATED

Sum of CATIONS = 4.050E-01 Sum of ANIONS 4.050E-01

PERCENT DIFFERENCE = 1.239E-04 (ANIONS - CATIONS)/(ANIONS + CATIONS)

EQUILIBRIUM IONIC STRENGTH (m) = 4.099E-01

EQUILIBRIUM pH = 8.296

DATE ID NUMBER: 940826
TIME ID NUMBER: 9263624

Run 2 - 10 g/l Na; sample 6; pH 7,2
add HNO3

Type I - COMPONENTS AS SPECIES IN SOLUTION

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
330	H+1	9.185E-08	6.510E-08	-7.18644	0.70876	0.149
500	Na+1	4.138E-01	2.933E-01	-0.53274	0.70876	0.149
140	CO3-2	3.697E-04	9.330E-05	-4.03011	0.25235	0.598
492	NO3-1	2.329E-01	1.651E-01	-0.78234	0.70876	0.149

Type II - OTHER SPECIES IN SOLUTION OR ADSORBED

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
3301401	H2CO3 AQ	1.703E-02	1.873E-02	-1.72748	1.10006	16.634
3300020	OH-	2.303E-07	1.632E-07	-6.78719	0.70876	-13.816
5001400	NaCO3 -	7.525E-04	5.333E-04	-3.27301	0.70876	1.439
5001401	NaHCO3 AQ	1.947E-02	2.141E-02	-1.66928	1.10006	10.039
3301400	HCO3 -	1.794E-01	1.271E-01	-0.89573	0.70876	10.470

Type III - SPECIES WITH FIXED ACTIVITY

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
2	H2O	-2.303E-07	-6.638	0.008	0.000

Type VI - EXCLUDED SPECIES (not included in mole balance)

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
3301403	CO2 (g)	5.808E-01	-0.236	18.159	-0.530

PERCENTAGE DISTRIBUTION OF COMPONENTS AMONG
TYPE I and TYPE II (dissolved and adsorbed) species

H+1

14.6	PERCENT BOUND IN SPECIES	#3301401	H2CO3 AQ
8.4	PERCENT BOUND IN SPECIES	#5001401	NaHCO3 AQ
77.0	PERCENT BOUND IN SPECIES	#3301400	HCO3 -

Na+1

95.3	PERCENT BOUND IN SPECIES	# 500	Na+1
4.5	PERCENT BOUND IN SPECIES	#5001401	NaHCO3 AQ

CO3-2

7.8	PERCENT BOUND IN SPECIES	#3301401	H2CO3 AQ
9.0	PERCENT BOUND IN SPECIES	#5001401	NaHCO3 AQ
82.7	PERCENT BOUND IN SPECIES	#3301400	HCO3 -

NO3-1

100.0	PERCENT BOUND IN SPECIES	# 492	NO3-1

H2O

100.0	PERCENT BOUND IN SPECIES	#3300020	OH-

----------- EQUILIBRATED MASS DISTRIBUTION -----------

IDX	NAME	DISSOLVED		SORBED		PRECIPITATED	
		MOL/KG	PERCENT	MOL/KG	PERCENT	MOL/KG	PERCENT
330	H+1	2.329E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
500	Na+1	4.340E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
140	CO3-2	2.170E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
492	NO3-1	2.329E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
2	H2O	2.303E-07	100.0	0.000E-01	0.0	0.000E-01	0.0

Charge Balance: SPECIATED

Sum of CATIONS = 4.138E-01 Sum of ANIONS 4.138E-01

PERCENT DIFFERENCE = 5.844E-04 (ANIONS - CATIONS)/(ANIONS + CATIONS)

EQUILIBRIUM IONIC STRENGTH (m) = 4.142E-01

EQUILIBRIUM pH = 7.186

DATE ID NUMBER: 940826
TIME ID NUMBER: 9243337

PC MINTEQA2 v3.10   DATE OF CALCULATIONS: 26-AUG-94 TIME: 9:37:23

RUN 3 - 30 g/l Na; sample 1; pH 11.5
add HNO3

Type I - COMPONENTS AS SPECIES IN SOLUTION

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
330	H+1	5.287E-12	3.844E-12	-11.41527	0.72704	0.138
500	Na+1	7.793E-01	5.666E-01	-0.24675	0.72704	0.138
140	CO3-2	1.235E-01	3.450E-02	-1.46221	0.27940	0.554
492	NO3-1	8.040E-04	5.845E-04	-3.23319	0.72704	0.138

Type II - OTHER SPECIES IN SOLUTION OR ADSORBED

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
3301401	H2CO3 AQ	1.961E-08	2.414E-08	-7.61725	1.23105	16.585
3300020	OH-	3.747E-03	2.724E-03	-2.56474	0.72704	-13.827
5001400	NaCO3 -	5.240E-01	3.810E-01	-0.41913	0.72704	1.428
5001401	NaHCO3 AQ	7.337E-04	9.032E-04	-3.04423	1.23105	9.990
3301400	HCO3 -	3.817E-03	2.775E-03	-2.55667	0.72704	10.459

Type III - SPECIES WITH FIXED ACTIVITY

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
2	H2O	-3.747E-03	-2.426	0.015	0.000

Type VI - EXCLUDED SPECIES (not included in mole balance)

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
3301403	CO2 (g)	7.597E-07	-6.119	18.159	-0.530

PERCENTAGE DISTRIBUTION OF COMPONENTS AMONG
TYPE I and TYPE II (dissolved and adsorbed) species

H+1
91.3 PERCENT BOUND IN SPECIES #5001401 NaHCO3 AQ

474.8 PERCENT BOUND IN SPECIES #3301400 HCO3 -

Na+1
59.8 PERCENT BOUND IN SPECIES # 500 Na+1

40.2 PERCENT BOUND IN SPECIES #5001400 NaCO3 -

CO3-2
18.9 PERCENT BOUND IN SPECIES # 140 CO3-2

80.4 PERCENT BOUND IN SPECIES #5001400 NaCO3 -

NO3-1
100.0 PERCENT BOUND IN SPECIES # 492 NO3-1

H2O
100.0 PERCENT BOUND IN SPECIES #3300020 OH-

----------- EQUILIBRATED MASS DISTRIBUTION -----------

IDX	NAME	DISSOLVED		SORBED		PRECIPITATED	
		MOL/KG	PERCENT	MOL/KG	PERCENT	MOL/KG	PERCENT
330	H+1	8.040E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
500	Na+1	1.304E+00	100.0	0.000E-01	0.0	0.000E-01	0.0
140	CO3-2	6.520E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
492	NO3-1	8.040E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
2	H2O	3.747E-03	100.0	0.000E-01	0.0	0.000E-01	0.0

Charge Balance: SPECIATED

Sum of CATIONS = 7.793E-01 Sum of ANIONS 7.793E-01

PERCENT DIFFERENCE = 4.798E-06 (ANIONS - CATIONS)/(ANIONS + CATIONS)

EQUILIBRIUM IONIC STRENGTH (m) = 9.028E-01

EQUILIBRIUM pH = 11.415

DATE ID NUMBER: 940902
TIME ID NUMBER: 18180796

RUN 3 - 30 g/l Na; sample 2; pH 10.6
add HNO3

Type I - COMPONENTS AS SPECIES IN SOLUTION

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
330	H+1	3.452E-11	2.512E-11	-10.59999	0.72764	0.138
500	Na+1	7.927E-01	5.768E-01	-0.23897	0.72764	0.138
140	CO3-2	1.170E-01	3.280E-02	-1.48418	0.28033	0.552
492	NO3-1	2.776E-02	2.020E-02	-1.69464	0.72764	0.138

Type II - OTHER SPECIES IN SOLUTION OR ADSORBED

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
3301401	H2CO3 AQ	7.950E-07	9.802E-07	-6.00867	1.23300	16.585
3300020	OH-	5.724E-04	4.165E-04	-3.38042	0.72764	-13.827
5001400	NaCO3 -	5.067E-01	3.687E-01	-0.43331	0.72764	1.428
5001401	NaHCO3 AQ	4.633E-03	5.713E-03	-2.24314	1.23300	9.989
3301400	HCO3 -	2.370E-02	1.724E-02	-1.76336	0.72764	10.459

Type III - SPECIES WITH FIXED ACTIVITY

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
2	H2O	-5.724E-04	-3.242	0.015	0.000

Type VI - EXCLUDED SPECIES (not included in mole balance)

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
3301403	CO2 (g)	3.088E-05	-4.510	18.159	-0.530

PERCENTAGE DISTRIBUTION OF COMPONENTS AMONG
TYPE I and TYPE II (dissolved and adsorbed) species

H+1
16.7 PERCENT BOUND IN SPECIES #5001401 NaHCO3 AQ

85.4 PERCENT BOUND IN SPECIES #3301400 HCO3 -

Na+1
60.8 PERCENT BOUND IN SPECIES # 500 Na+1

38.9 PERCENT BOUND IN SPECIES #5001400 NaCO3 -

CO3-2
17.9 PERCENT BOUND IN SPECIES # 140 CO3-2

77.7 PERCENT BOUND IN SPECIES #5001400 NaCO3 -

3.6 PERCENT BOUND IN SPECIES #3301400 HCO3 -

NO3-1
100.0 PERCENT BOUND IN SPECIES # 492 NO3-1

H2O
100.0 PERCENT BOUND IN SPECIES #3300020 OH-

----------- EQUILIBRATED MASS DISTRIBUTION -----------

IDX	NAME	DISSOLVED		SORBED		PRECIPITATED	
		MOL/KG	PERCENT	MOL/KG	PERCENT	MOL/KG	PERCENT
330	H+1	2.776E-02	100.0	0.000E-01	0.0	0.000E-01	0.0
500	Na+1	1.304E+00	100.0	0.000E-01	0.0	0.000E-01	0.0
140	CO3-2	6.520E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
492	NO3-1	2.776E-02	100.0	0.000E-01	0.0	0.000E-01	0.0
2	H2O	5.724E-04	100.0	0.000E-01	0.0	0.000E-01	0.0

Charge Balance: SPECIATED

Sum of CATIONS = 7.927E-01 Sum of ANIONS 7.927E-01

PERCENT DIFFERENCE = 1.989E-03 (ANIONS - CATIONS)/(ANIONS + CATIONS)

EQUILIBRIUM IONIC STRENGTH (m) = 9.096E-01

EQUILIBRIUM pH = 10.600

DATE ID NUMBER: 940902
TIME ID NUMBER: 18092468

Run 3 - 30 g/l Na; sample 3; pH 9.6
add HNO3

Type I - COMPONENTS AS SPECIES IN SOLUTION

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
330	H+1	3.434E-10	2.516E-10	-9.59937	0.73263	0.135
500	Na+1	8.873E-01	6.501E-01	-0.18703	0.73263	0.135
140	CO3-2	7.663E-02	2.208E-02	-1.65605	0.28809	0.540
492	NO3-1	1.935E-01	1.418E-01	-0.84846	0.73263	0.135

Type II - OTHER SPECIES IN SOLUTION OR ADSORBED

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
3301401	H2CO3 AQ	5.300E-05	6.618E-05	-4.17930	1.24854	16.579
3300020	OH-	5.643E-05	4.134E-05	-4.38358	0.73263	-13.830
5001400	NaCO3 -	3.818E-01	2.797E-01	-0.55325	0.73263	1.425
5001401	NaHCO3 AQ	3.477E-02	4.341E-02	-1.36245	1.24854	9.984
3301400	HCO3 -	1.587E-01	1.162E-01	-0.93461	0.73263	10.456

Type III - SPECIES WITH FIXED ACTIVITY

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
2	H2O	-5.643E-05	-4.248	0.018	0.000

Type VI - EXCLUDED SPECIES (not included in mole balance)

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
3301403	CO2 (g)	2.097E-03	-2.678	18.159	-0.530

PERCENTAGE DISTRIBUTION OF COMPONENTS AMONG
TYPE I and TYPE II (dissolved and adsorbed) species

H+1

18.0	PERCENT BOUND IN SPECIES	#5001401	NaHCO3 AQ
82.0	PERCENT BOUND IN SPECIES	#3301400	HCO3 -

Na+1

68.1	PERCENT BOUND IN SPECIES	# 500	Na+1
29.3	PERCENT BOUND IN SPECIES	#5001400	NaCO3 -
2.7	PERCENT BOUND IN SPECIES	#5001401	NaHCO3 AQ

CO3-2

11.8	PERCENT BOUND IN SPECIES	# 140	CO3-2
58.6	PERCENT BOUND IN SPECIES	#5001400	NaCO3 -
5.3	PERCENT BOUND IN SPECIES	#5001401	NaHCO3 AQ
24.3	PERCENT BOUND IN SPECIES	#3301400	HCO3 -

NO3-1

100.0	PERCENT BOUND IN SPECIES	# 492	NO3-1

H2O

100.0	PERCENT BOUND IN SPECIES	#3300020	OH-

----------- EQUILIBRATED MASS DISTRIBUTION -----------

IDX	NAME	DISSOLVED		SORBED		PRECIPITATED	
		MOL/KG	PERCENT	MOL/KG	PERCENT	MOL/KG	PERCENT
330	H+1	1.935E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
500	Na+1	1.304E+00	100.0	0.000E-01	0.0	0.000E-01	0.0
140	CO3-2	6.520E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
492	NO3-1	1.935E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
2	H2O	5.643E-05	100.0	0.000E-01	0.0	0.000E-01	0.0

Charge Balance: SPECIATED

Sum of CATIONS = 8.873E-01 Sum of ANIONS 8.873E-01

PERCENT DIFFERENCE = 1.273E-03 (ANIONS - CATIONS)/(ANIONS + CATIONS)

EQUILIBRIUM IONIC STRENGTH (m) = 9.640E-01

EQUILIBRIUM pH = 9.599

DATE ID NUMBER: 940826
TIME ID NUMBER: 9515625

Run 3 - 30 g/l Na; sample 4; pH 9,1
add HNO3

Type I - COMPONENTS AS SPECIES IN SOLUTION

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
330	H+1	1.080E-09	7.985E-10	-9.09774	0.73909	0.131
500	Na+1	9.860E-01	7.287E-01	-0.13742	0.73909	0.131
140	CO3-2	4.307E-02	1.285E-02	-1.89101	0.29840	0.525
492	NO3-1	3.622E-01	2.677E-01	-0.57237	0.73909	0.131

Type II - OTHER SPECIES IN SOLUTION OR ADSORBED

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
3301401	H2CO3 AQ	3.063E-04	3.882E-04	-3.41100	1.26739	16.573
3300020	OH-	1.752E-05	1.295E-05	-4.88782	0.73909	-13.834
5001400	NaCO3 -	2.470E-01	1.826E-01	-0.73860	0.73909	1.421
5001401	NaHCO3 AQ	7.094E-02	8.991E-02	-1.04617	1.26739	9.977
3301400	HCO3 -	2.906E-01	2.148E-01	-0.66794	0.73909	10.452

Type III - SPECIES WITH FIXED ACTIVITY

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
2	H2O	-1.752E-05	-4.757	0.020	0.000

Type VI - EXCLUDED SPECIES (not included in mole balance)

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
3301403	CO2 (g)	1.237E-02	-1.908	18.159	-0.530

PERCENTAGE DISTRIBUTION OF COMPONENTS AMONG
TYPE I and TYPE II (dissolved and adsorbed) species

H+1

19.6	PERCENT BOUND IN SPECIES	#5001401	NaHCO3 AQ
80.2	PERCENT BOUND IN SPECIES	#3301400	HCO3 -

Na+1

75.6	PERCENT BOUND IN SPECIES	# 500	Na+1
18.9	PERCENT BOUND IN SPECIES	#5001400	NaCO3 -
5.4	PERCENT BOUND IN SPECIES	#5001401	NaHCO3 AQ

CO3-2

6.6	PERCENT BOUND IN SPECIES	# 140	CO3-2
37.9	PERCENT BOUND IN SPECIES	#5001400	NaCO3 -
10.9	PERCENT BOUND IN SPECIES	#5001401	NaHCO3 AQ
44.6	PERCENT BOUND IN SPECIES	#3301400	HCO3 -

NO3-1

100.0	PERCENT BOUND IN SPECIES	# 492	NO3-1

H2O

100.0	PERCENT BOUND IN SPECIES	#3300020	OH-

----------- EQUILIBRATED MASS DISTRIBUTION -----------

IDX	NAME	DISSOLVED		SORBED		PRECIPITATED	
		MOL/KG	PERCENT	MOL/KG	PERCENT	MOL/KG	PERCENT
330	H+1	3.622E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
500	Na+1	1.304E+00	100.0	0.000E-01	0.0	0.000E-01	0.0
140	CO3-2	6.520E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
492	NO3-1	3.622E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
2	H2O	1.752E-05	100.0	0.000E-01	0.0	0.000E-01	0.0

Charge Balance: SPECIATED

Sum of CATIONS = 9.860E-01 Sum of ANIONS 9.860E-01

PERCENT DIFFERENCE = 4.689E-04 (ANIONS - CATIONS)/(ANIONS + CATIONS)

EQUILIBRIUM IONIC STRENGTH (m) = 1.029E+00

EQUILIBRIUM pH = 9.098

DATE ID NUMBER: 940826
TIME ID NUMBER: 9501892

Run 3 - 30 g/l Na; sample 5; pH 8,5
add HNO3

Type I - COMPONENTS AS SPECIES IN SOLUTION

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
330	H+1	4.284E-09	3.201E-09	-8.49471	0.74726	0.127
500	Na+1	1.090E+00	8.145E-01	-0.08909	0.74726	0.127
140	CO3-2	1.506E-02	4.697E-03	-2.32815	0.31181	0.506
492	NO3-1	5.389E-01	4.027E-01	-0.39502	0.74726	0.127

Type II - OTHER SPECIES IN SOLUTION OR ADSORBED

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
3301401	H2CO3 AQ	1.768E-03	2.280E-03	-2.64207	1.28976	16.565
3300020	OH-	4.295E-06	3.209E-06	-5.49359	0.74726	-13.839
5001400	NaCO3 -	9.980E-02	7.458E-02	-1.12740	0.74726	1.416
5001401	NaHCO3 AQ	1.142E-01	1.473E-01	-0.83194	1.28976	9.969
3301400	HCO3 -	4.212E-01	3.147E-01	-0.50204	0.74726	10.447

Type III - SPECIES WITH FIXED ACTIVITY

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
2	H2O	-4.295E-06	-5.367	0.023	0.000

Type VI - EXCLUDED SPECIES (not included in mole balance)

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
3301403	CO2 (g)	7.314E-02	-1.136	18.159	-0.530

PERCENTAGE DISTRIBUTION OF COMPONENTS AMONG
TYPE I and TYPE II (dissolved and adsorbed) species

H+1

21.2	PERCENT BOUND IN SPECIES #5001401		NaHCO3 AQ
78.2	PERCENT BOUND IN SPECIES #3301400		HCO3 -

Na+1

83.6	PERCENT BOUND IN SPECIES #	500	Na+1
7.7	PERCENT BOUND IN SPECIES #5001400		NaCO3 -
8.8	PERCENT BOUND IN SPECIES #5001401		NaHCO3 AQ

CO3-2

2.3	PERCENT BOUND IN SPECIES #	140	CO3-2
15.3	PERCENT BOUND IN SPECIES #5001400		NaCO3 -
17.5	PERCENT BOUND IN SPECIES #5001401		NaHCO3 AQ
64.6	PERCENT BOUND IN SPECIES #3301400		HCO3 -

NO3-1

100.0	PERCENT BOUND IN SPECIES #	492	NO3-1

H2O

100.0	PERCENT BOUND IN SPECIES #3300020		OH-

----------- EQUILIBRATED MASS DISTRIBUTION -----------

IDX	NAME	DISSOLVED		SORBED		PRECIPITATED	
		MOL/KG	PERCENT	MOL/KG	PERCENT	MOL/KG	PERCENT
330	H+1	5.389E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
500	Na+1	1.304E+00	100.0	0.000E-01	0.0	0.000E-01	0.0
140	CO3-2	6.520E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
492	NO3-1	5.389E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
2	H2O	4.295E-06	100.0	0.000E-01	0.0	0.000E-01	0.0

Charge Balance: SPECIATED

Sum of CATIONS = 1.090E+00 Sum of ANIONS 1.090E+00

PERCENT DIFFERENCE = 6.841E-06 (ANIONS - CATIONS)/(ANIONS + CATIONS)

EQUILIBRIUM IONIC STRENGTH (m) = 1.105E+00

EQUILIBRIUM pH = 8.495

DATE ID NUMBER: 940826
TIME ID NUMBER: 9483692

Run 3 - 30 g/l Na; sample 6; pH 7,9
add HNO3

Type I - COMPONENTS AS SPECIES IN SOLUTION

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
330	H+1	1.709E-08	1.284E-08	-7.89136	0.75165	0.124
500	Na+1	1.139E+00	8.564E-01	-0.06732	0.75165	0.124
140	CO3-2	4.163E-03	1.329E-03	-2.87650	0.31920	0.496
492	NO3-1	6.263E-01	4.707E-01	-0.32723	0.75165	0.124

Type II - OTHER SPECIES IN SOLUTION OR ADSORBED

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
3301401	H2CO3 AQ	7.978E-03	1.038E-02	-1.98372	1.30125	16.561
3300020	OH-	1.061E-06	7.974E-07	-6.09830	0.75165	-13.841
5001400	NaCO3 -	2.951E-02	2.218E-02	-1.65399	0.75165	1.414
5001401	NaHCO3 AQ	1.350E-01	1.757E-01	-0.75518	1.30125	9.966
3301400	HCO3 -	4.753E-01	3.572E-01	-0.44705	0.75165	10.445

Type III - SPECIES WITH FIXED ACTIVITY

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
2	H2O	-1.061E-06	-5.974	0.024	0.000

Type VI - EXCLUDED SPECIES (not included in mole balance)

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
3301403	CO2 (g)	3.341E-01	-0.476	18.159	-0.530

PERCENTAGE DISTRIBUTION OF COMPONENTS AMONG
TYPE I and TYPE II (dissolved and adsorbed) species

H+1

2.5	PERCENT BOUND IN SPECIES	#3301401	H2CO3 AQ
21.6	PERCENT BOUND IN SPECIES	#5001401	NaHCO3 AQ
75.9	PERCENT BOUND IN SPECIES	#3301400	HCO3 -

Na+1

87.4	PERCENT BOUND IN SPECIES	# 500	Na+1
2.3	PERCENT BOUND IN SPECIES	#5001400	NaCO3 -
10.4	PERCENT BOUND IN SPECIES	#5001401	NaHCO3 AQ

CO3-2

1.2	PERCENT BOUND IN SPECIES	#3301401	H2CO3 AQ
4.5	PERCENT BOUND IN SPECIES	#5001400	NaCO3 -
20.7	PERCENT BOUND IN SPECIES	#5001401	NaHCO3 AQ
72.9	PERCENT BOUND IN SPECIES	#3301400	HCO3 -

NO3-1

100.0	PERCENT BOUND IN SPECIES	# 492	NO3-1

H2O

100.0	PERCENT BOUND IN SPECIES	#3300020	OH-

----------- EQUILIBRATED MASS DISTRIBUTION -----------

IDX	NAME	DISSOLVED MOL/KG	DISSOLVED PERCENT	SORBED MOL/KG	SORBED PERCENT	PRECIPITATED MOL/KG	PRECIPITATED PERCENT
330	H+1	6.263E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
500	Na+1	1.304E+00	100.0	0.000E-01	0.0	0.000E-01	0.0
140	CO3-2	6.520E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
492	NO3-1	6.263E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
2	H2O	1.061E-06	100.0	0.000E-01	0.0	0.000E-01	0.0

Charge Balance: SPECIATED

Sum of CATIONS = 1.139E+00 Sum of ANIONS 1.139E+00

PERCENT DIFFERENCE = 5.895E-05 (ANIONS - CATIONS)/(ANIONS + CATIONS)

EQUILIBRIUM IONIC STRENGTH (m) = 1.144E+00

EQUILIBRIUM pH = 7.891

DATE ID NUMBER: 940826
TIME ID NUMBER: 9443305

Run 4 - 10 g/l Na; 10 mg/l Ca; 10 mg/l Mg; sample 1; pH 11,0
add HNO3

Type I - COMPONENTS AS SPECIES IN SOLUTION

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
330	H+1	6.612E-12	4.693E-12	-11.32852	0.70987	0.149
500	Na+1	3.054E-01	2.168E-01	-0.66391	0.70987	0.149
140	CO3-2	8.489E-02	2.156E-02	-1.66643	0.25393	0.595
150	Ca+2	3.010E-05	7.644E-06	-5.11669	0.25393	0.595
180	Cl-1	5.000E-04	3.549E-04	-3.44985	0.70987	0.149
460	Mg+2	7.008E-05	1.780E-05	-4.74969	0.25393	0.595
492	NO3-1	1.408E-11	9.995E-12	-11.00022	0.70987	0.149

Type II - OTHER SPECIES IN SOLUTION OR ADSORBED

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
3301401	H2CO3 AQ	2.056E-08	2.249E-08	-7.64797	1.09401	16.636
3300020	OH-	3.215E-03	2.282E-03	-2.64163	0.70987	-13.816
4603300	MgOH +	9.474E-06	6.725E-06	-5.17229	0.70987	-11.597
4601400	MgCO3 AQ	3.398E-04	3.718E-04	-3.42972	1.09401	2.947
4601401	MgHCO3 +	6.212E-07	4.410E-07	-6.35559	0.70987	11.538
1503300	CaOH +	6.215E-07	4.412E-07	-6.35540	0.70987	-12.414
1501400	CaHCO3 +	2.437E-07	1.730E-07	-6.76200	0.70987	11.498
1501401	CaCO3 AQ	2.190E-04	2.396E-04	-3.62047	1.09401	3.124
5001400	NaCO3 -	1.283E-01	9.109E-02	-1.04051	0.70987	1.439
5001401	NaHCO3 AQ	2.411E-04	2.637E-04	-3.57886	1.09401	10.041
3301400	HCO3 -	2.983E-03	2.118E-03	-2.67414	0.70987	10.470

Type III - SPECIES WITH FIXED ACTIVITY

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
2	H2O	-3.225E-03	-2.491	0.005	0.000

Type VI - EXCLUDED SPECIES (not included in mole balance)

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
3301403	CO2 (g)	6.920E-07	-6.160	18.159	-0.530

PERCENTAGE DISTRIBUTION OF COMPONENTS AMONG
TYPE I and TYPE II (dissolved and adsorbed) species

H+1

>1000. PERCENT BOUND IN SPECIES #3300020 OH-

>1000. PERCENT BOUND IN SPECIES #4603300 MgOH +

>1000. PERCENT BOUND IN SPECIES #1503300 CaOH +

Na+1

70.4 PERCENT BOUND IN SPECIES # 500 Na+1

29.6 PERCENT BOUND IN SPECIES #5001400 NaCO3 -

CO3-2

39.1 PERCENT BOUND IN SPECIES # 140 CO3-2

59.1 PERCENT BOUND IN SPECIES #5001400 NaCO3 -

1.4 PERCENT BOUND IN SPECIES #3301400 HCO3 -

Ca+2

12.0 PERCENT BOUND IN SPECIES # 150 Ca+2

87.6 PERCENT BOUND IN SPECIES #1501401 CaCO3 AQ

Cl-1

100.0 PERCENT BOUND IN SPECIES # 180 Cl-1

Mg+2

16.7 PERCENT BOUND IN SPECIES # 460 Mg+2

2.3 PERCENT BOUND IN SPECIES #4603300 MgOH +

80.9 PERCENT BOUND IN SPECIES #4601400 MgCO3 AQ

NO3-1

100.0 PERCENT BOUND IN SPECIES # 492 NO3-1

H2O

99.7 PERCENT BOUND IN SPECIES #3300020 OH-

----------- EQUILIBRATED MASS DISTRIBUTION -----------

IDX	NAME	DISSOLVED MOL/KG	DISSOLVED PERCENT	SORBED MOL/KG	SORBED PERCENT	PRECIPITATED MOL/KG	PRECIPITATED PERCENT
330	H+1	-4.704E-10	100.0	0.000E-01	0.0	0.000E-01	0.0
500	Na+1	4.340E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
140	CO3-2	2.170E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
150	Ca+2	2.500E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
180	Cl-1	5.000E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
460	Mg+2	4.200E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
492	NO3-1	1.408E-11	100.0	0.000E-01	0.0	0.000E-01	0.0
2	H2O	3.225E-03	100.0	0.000E-01	0.0	0.000E-01	0.0

Charge Balance: SPECIATED

Sum of CATIONS = 3.056E-01 Sum of ANIONS 3.048E-01

PERCENT DIFFERENCE = 1.376E-01 (ANIONS - CATIONS)/(ANIONS + CATIONS)

EQUILIBRIUM IONIC STRENGTH (m) = 3.902E-01

EQUILIBRIUM pH = 11.329

DATE ID NUMBER: 940826
TIME ID NUMBER: 12011354

Saturation indices and stoichiometry of all minerals

ID #	NAME	Sat. Index	Stoichiometry in [brackets]		
5015000	ARAGONITE	1.562	[1.000] 150	[1.000] 140	
5046000	ARTINITE	1.937	[-2.000] 330	[2.000] 460	[1.000] 140
			[5.000] 2		
2046000	BRUCITE	1.169	[1.000] 460	[2.000] 2	[-2.000] 330
5015001	CALCITE	1.698	[1.000] 150	[1.000] 140	
5015002	DOLOMITE	3.821	[1.000] 150	[1.000] 460	[2.000] 140
4150000	HALITE	-5.698	[1.000] 500	[1.000] 180	
5015003	HUNTITE	4.000	[3.000] 460	[1.000] 150	[4.000] 140
5046001	HYDRMAGNESIT	1.108	[5.000] 460	[4.000] 140	[-2.000] 330
			[6.000] 2		
5046002	MAGNESITE	1.628	[1.000] 460	[1.000] 140	
3050000	NATRON	-1.770	[2.000] 500	[1.000] 140	[10.000] 2
5046003	NESQUEHONITE	-0.795	[1.000] 460	[1.000] 140	[3.000] 2
5050001	THERMONATR	-3.117	[2.000] 500	[1.000] 140	[1.000] 2
2015000	LIME	-15.148	[-2.000] 330	[1.000] 150	[1.000] 2
2015001	PORTLANDITE	-5.069	[-2.000] 330	[1.000] 150	[2.000] 2
2046001	PERICLASE	-3.519	[-2.000] 330	[1.000] 460	[1.000] 2

Run 4 - 10 g/l Na; 10 mg/l Ca; 10 mg/l Mg; sample 2; pH 10,0
add HNO3

Type I - COMPONENTS AS SPECIES IN SOLUTION

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
330	H+1	1.412E-10	1.002E-10	-9.99899	0.70984	0.149
500	Na+1	3.278E-01	2.327E-01	-0.63327	0.70984	0.149
140	CO3-2	6.297E-02	1.599E-02	-1.79623	0.25389	0.595
150	Ca+2	3.832E-05	9.729E-06	-5.01195	0.25389	0.595
180	Cl-1	5.000E-04	3.549E-04	-3.44987	0.70984	0.149
460	Mg+2	8.857E-05	2.249E-05	-4.64807	0.25389	0.595
492	NO3-1	5.124E-02	3.637E-02	-1.43923	0.70984	0.149

Type II - OTHER SPECIES IN SOLUTION OR ADSORBED

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
3301401	H2CO3 AQ	6.954E-06	7.608E-06	-5.11872	1.09414	16.636
3300020	OH-	1.503E-04	1.067E-04	-3.97192	0.70984	-13.816
4603300	MgOH +	5.596E-07	3.972E-07	-6.40097	0.70984	-11.597
4601400	MgCO3 AQ	3.184E-04	3.484E-04	-3.45791	1.09414	2.947
4601401	MgHCO3 +	1.243E-05	8.826E-06	-5.05425	0.70984	11.538
1503300	CaOH +	3.697E-08	2.625E-08	-7.58095	0.70984	-12.414
1501400	CaHCO3 +	4.913E-06	3.487E-06	-5.45753	0.70984	11.498
1501401	CaCO3 AQ	2.067E-04	2.262E-04	-3.64553	1.09414	3.124
5001400	NaCO3 -	1.021E-01	7.250E-02	-1.13967	0.70984	1.439
5001401	NaHCO3 AQ	4.097E-03	4.482E-03	-2.34849	1.09414	10.041
3301400	HCO3 -	4.725E-02	3.354E-02	-1.47441	0.70984	10.470

Type III - SPECIES WITH FIXED ACTIVITY

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
2	H2O	-1.509E-04	-3.821	0.006	0.000

Type VI - EXCLUDED SPECIES (not included in mole balance)

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
3301403	CO2 (g)	2.345E-04	-3.630	18.159	-0.530

PERCENTAGE DISTRIBUTION OF COMPONENTS AMONG
TYPE I and TYPE II (dissolved and adsorbed) species

H+1

8.0 PERCENT BOUND IN SPECIES #5001401 NaHCO3 AQ

92.2 PERCENT BOUND IN SPECIES #3301400 HCO3 -

Na+1

75.5 PERCENT BOUND IN SPECIES # 500 Na+1

23.5 PERCENT BOUND IN SPECIES #5001400 NaCO3 -

CO3-2

29.0 PERCENT BOUND IN SPECIES # 140 CO3-2

47.1 PERCENT BOUND IN SPECIES #5001400 NaCO3 -

1.9 PERCENT BOUND IN SPECIES #5001401 NaHCO3 AQ

21.8 PERCENT BOUND IN SPECIES #3301400 HCO3 -

Ca+2

15.3 PERCENT BOUND IN SPECIES # 150 Ca+2

2.0 PERCENT BOUND IN SPECIES #1501400 CaHCO3 +

	82.7	PERCENT BOUND IN SPECIES	#1501401	CaCO3 AQ
Cl-1				
	100.0	PERCENT BOUND IN SPECIES	# 180	Cl-1
Mg+2				
	21.1	PERCENT BOUND IN SPECIES	# 460	Mg+2
	75.8	PERCENT BOUND IN SPECIES	#4601400	MgCO3 AQ
	3.0	PERCENT BOUND IN SPECIES	#4601401	MgHCO3 +
NO3-1				
	100.0	PERCENT BOUND IN SPECIES	# 492	NO3-1
H2O				
	99.6	PERCENT BOUND IN SPECIES	#3300020	OH-

----------- EQUILIBRATED MASS DISTRIBUTION -----------

IDX	NAME	DISSOLVED MOL/KG	DISSOLVED PERCENT	SORBED MOL/KG	SORBED PERCENT	PRECIPITATED MOL/KG	PRECIPITATED PERCENT
330	H+1	5.123E-02	100.0	0.000E-01	0.0	0.000E-01	0.0
500	Na+1	4.340E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
140	CO3-2	2.170E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
150	Ca+2	2.500E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
180	Cl-1	5.000E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
460	Mg+2	4.200E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
492	NO3-1	5.124E-02	100.0	0.000E-01	0.0	0.000E-01	0.0
2	H2O	1.509E-04	100.0	0.000E-01	0.0	0.000E-01	0.0

Charge Balance: SPECIATED

Sum of CATIONS = 3.280E-01 Sum of ANIONS 3.272E-01

PERCENT DIFFERENCE = 1.264E-01 (ANIONS - CATIONS)/(ANIONS + CATIONS)

EQUILIBRIUM IONIC STRENGTH (m) = 3.907E-01

EQUILIBRIUM pH = 9.999

DATE ID NUMBER: 940826
TIME ID NUMBER: 15122605

Saturation indices and stoichiometry of all minerals

ID #	NAME	Sat. Index	Stoichiometry in [brackets]		
5015000	ARAGONITE	1.537	[1.000] 150	[1.000] 140	
5046000	ARTINITE	-0.652	[-2.000] 330	[2.000] 460	[1.000] 140
			[5.000] 2		
2046000	BRUCITE	-1.390	[1.000] 460	[2.000] 2	[-2.000] 330
5015001	CALCITE	1.673	[1.000] 150	[1.000] 140	
5015002	DOLOMITE	3.768	[1.000] 150	[1.000] 460	[2.000] 140
4150000	HALITE	-5.667	[1.000] 500	[1.000] 180	
5015003	HUNTITE	3.890	[3.000] 460	[1.000] 150	[4.000] 140
5046001	HYDRMAGNESIT	-1.567	[5.000] 460	[4.000] 140	[-2.000] 330
			[6.000] 2		
5046002	MAGNESITE	1.600	[1.000] 460	[1.000] 140	
3050000	NATRON	-1.846	[2.000] 500	[1.000] 140	[10.000] 2
5046003	NESQUEHONITE	-0.826	[1.000] 460	[1.000] 140	[3.000] 2
5050001	THERMONATR	-3.187	[2.000] 500	[1.000] 140	[1.000] 2
2015000	LIME	-17.703	[-2.000] 330	[1.000] 150	[1.000] 2
2015001	PORTLANDITE	-7.625	[-2.000] 330	[1.000] 150	[2.000] 2
2046001	PERICLASE	-6.077	[-2.000] 330	[1.000] 460	[1.000] 2

Run 4 - 10 g/l Na; 10 mg/l Ca; 10 mg/l Mg; sample 3; pH 9,0
add HNO3

Type I - COMPONENTS AS SPECIES IN SOLUTION

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
330	H+1	1.419E-09	1.006E-09	-8.99732	0.70926	0.149
500	Na+1	3.827E-01	2.715E-01	-0.56629	0.70926	0.149
140	CO3-2	1.939E-02	4.907E-03	-2.30922	0.25306	0.597
150	Ca+2	8.223E-05	2.081E-05	-4.68176	0.25306	0.597
180	Cl-1	5.000E-04	3.547E-04	-3.45018	0.70926	0.149
460	Mg+2	1.661E-04	4.203E-05	-4.37647	0.25306	0.597
492	NO3-1	1.609E-01	1.141E-01	-0.94260	0.70926	0.149

Type II - OTHER SPECIES IN SOLUTION OR ADSORBED

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
3301401	H2CO3 AQ	2.145E-04	2.353E-04	-3.62836	1.09711	16.635
3300020	OH-	1.493E-05	1.059E-05	-4.97523	0.70926	-13.816
4603300	MgOH +	1.039E-07	7.367E-08	-7.13268	0.70926	-11.597
4601400	MgCO3 AQ	1.822E-04	1.999E-04	-3.69929	1.09711	2.946
4601401	MgHCO3 +	7.165E-05	5.082E-05	-4.29397	0.70926	11.538
1503300	CaOH +	7.854E-09	5.571E-09	-8.25408	0.70926	-12.413
1501400	CaHCO3 +	3.240E-05	2.298E-05	-4.63866	0.70926	11.499
1501401	CaCO3 AQ	1.353E-04	1.485E-04	-3.82832	1.09711	3.122
5001400	NaCO3 -	3.660E-02	2.596E-02	-1.58567	0.70926	1.439
5001401	NaHCO3 AQ	1.469E-02	1.611E-02	-1.79282	1.09711	10.040
3301400	HCO3 -	1.457E-01	1.033E-01	-0.98572	0.70926	10.470

Type III - SPECIES WITH FIXED ACTIVITY

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
2	H2O	-1.504E-05	-4.823	0.007	0.000

Type VI - EXCLUDED SPECIES (not included in mole balance)

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
3301403	CO2 (g)	7.279E-03	-2.138	18.159	-0.530

PERCENTAGE DISTRIBUTION OF COMPONENTS AMONG
TYPE I and TYPE II (dissolved and adsorbed) species

H+1				
	9.1	PERCENT BOUND IN SPECIES	#5001401	NaHCO3 AQ
	90.6	PERCENT BOUND IN SPECIES	#3301400	HCO3 -
Na+1				
	88.2	PERCENT BOUND IN SPECIES	# 500	Na+1
	8.4	PERCENT BOUND IN SPECIES	#5001400	NaCO3 -
	3.4	PERCENT BOUND IN SPECIES	#5001401	NaHCO3 AQ
CO3-2				
	8.9	PERCENT BOUND IN SPECIES	# 140	CO3-2
	16.9	PERCENT BOUND IN SPECIES	#5001400	NaCO3 -
	6.8	PERCENT BOUND IN SPECIES	#5001401	NaHCO3 AQ
	67.1	PERCENT BOUND IN SPECIES	#3301400	HCO3 -

Ca+2			
	32.9	PERCENT BOUND IN SPECIES # 150	Ca+2
	13.0	PERCENT BOUND IN SPECIES #1501400	CaHCO3 +
	54.1	PERCENT BOUND IN SPECIES #1501401	CaCO3 AQ
Cl-1			
	100.0	PERCENT BOUND IN SPECIES # 180	Cl-1
Mg+2			
	39.5	PERCENT BOUND IN SPECIES # 460	Mg+2
	43.4	PERCENT BOUND IN SPECIES #4601400	MgCO3 AQ
	17.1	PERCENT BOUND IN SPECIES #4601401	MgHCO3 +
NO3-1			
	100.0	PERCENT BOUND IN SPECIES # 492	NO3-1
H2O			
	99.3	PERCENT BOUND IN SPECIES #3300020	OH-

----------- EQUILIBRATED MASS DISTRIBUTION -----------

IDX	NAME	DISSOLVED		SORBED		PRECIPITATED	
		MOL/KG	PERCENT	MOL/KG	PERCENT	MOL/KG	PERCENT
330	H+1	1.609E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
500	Na+1	4.340E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
140	CO3-2	2.170E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
150	Ca+2	2.500E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
180	Cl-1	5.000E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
460	Mg+2	4.200E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
492	NO3-1	1.609E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
2	H2O	1.504E-05	100.0	0.000E-01	0.0	0.000E-01	0.0

Charge Balance: SPECIATED

Sum of CATIONS = 3.833E-01 Sum of ANIONS 3.825E-01

PERCENT DIFFERENCE = 1.082E-01 (ANIONS - CATIONS)/(ANIONS + CATIONS)

EQUILIBRIUM IONIC STRENGTH (m) = 4.025E-01

EQUILIBRIUM pH = 8.997

DATE ID NUMBER: 940826
TIME ID NUMBER: 15102977

Saturation indices and stoichiometry of all minerals

ID #	NAME	Sat. Index	Stoichiometry in [brackets]					
5015000	ARAGONITE	1.354	[1.000]	150	[1.000]	140		
5046000	ARTINITE	-2.633	[-2.000]	330	[2.000]	460	[1.000]	140
			[5.000]	2				
2046000	BRUCITE	-3.125	[1.000]	460	[2.000]	2	[-2.000]	330
5015001	CALCITE	1.490	[1.000]	150	[1.000]	140		
5015002	DOLOMITE	3.344	[1.000]	150	[1.000]	460	[2.000]	140
4150000	HALITE	-5.601	[1.000]	500	[1.000]	180		
5015003	HUNTITE	2.983	[3.000]	460	[1.000]	150	[4.000]	140
5046001	HYDRMAGNESIT	-4.274	[5.000]	460	[4.000]	140	[-2.000]	330
			[6.000]	2				
5046002	MAGNESITE	1.358	[1.000]	460	[1.000]	140		
3050000	NATRON	-2.242	[2.000]	500	[1.000]	140	[10.000]	2
5046003	NESQUEHONITE	-1.072	[1.000]	460	[1.000]	140	[3.000]	2
5050001	THERMONATR	-3.567	[2.000]	500	[1.000]	140	[1.000]	2
2015000	LIME	-19.378	[-2.000]	330	[1.000]	150	[1.000]	2
2015001	PORTLANDITE	-9.301	[-2.000]	330	[1.000]	150	[2.000]	2
2046001	PERICLASE	-7.811	[-2.000]	330	[1.000]	460	[1.000]	2

Run 4 - 10 g/l Na; 10 mg/l Ca; 10 mg/l Mg; sample 4; pH 8,2
add HNO3

Type I - COMPONENTS AS SPECIES IN SOLUTION

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
330	H+1	8.988E-09	6.372E-09	-8.19576	0.70887	0.149
500	Na+1	4.066E-01	2.883E-01	-0.54022	0.70887	0.149
140	CO3-2	3.868E-03	9.767E-04	-3.01022	0.25251	0.598
150	Ca+2	1.372E-04	3.464E-05	-4.46037	0.25251	0.598
180	Cl-1	5.000E-04	3.544E-04	-3.45046	0.70887	0.149
460	Mg+2	2.386E-04	6.024E-05	-4.22011	0.25251	0.598
492	NO3-1	2.070E-01	1.467E-01	-0.83346	0.70887	0.149

Type II - OTHER SPECIES IN SOLUTION OR ADSORBED

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
3301401	H2CO3 AQ	1.709E-03	1.878E-03	-2.72624	1.09936	16.634
3300020	OH-	2.355E-06	1.669E-06	-5.77749	0.70887	-13.816
4603300	MgOH +	2.349E-08	1.665E-08	-7.77857	0.70887	-11.597
4601400	MgCO3 AQ	5.187E-05	5.703E-05	-4.24393	1.09936	2.945
4601401	MgHCO3 +	1.295E-04	9.182E-05	-4.03704	0.70887	11.538
1503300	CaOH +	2.063E-09	1.462E-09	-8.83494	0.70887	-12.413
1501400	CaHCO3 +	6.803E-05	4.823E-05	-4.31670	0.70887	11.499
1501401	CaCO3 AQ	4.476E-05	4.921E-05	-4.30793	1.09936	3.122
5001400	NaCO3 -	7.741E-03	5.488E-03	-2.26061	0.70887	1.439
5001401	NaHCO3 AQ	1.962E-02	2.157E-02	-1.66620	1.09936	10.039
3301400	HCO3 -	1.838E-01	1.303E-01	-0.88516	0.70887	10.470

Type III - SPECIES WITH FIXED ACTIVITY

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
2	H2O	-2.380E-06	-5.623	0.008	0.000

Type VI - EXCLUDED SPECIES (not included in mole balance)

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
3301403	CO2 (g)	5.820E-02	-1.235	18.159	-0.530

PERCENTAGE DISTRIBUTION OF COMPONENTS AMONG
TYPE I and TYPE II (dissolved and adsorbed) species

H+1			
	1.7	PERCENT BOUND IN SPECIES #3301401	H2CO3 AQ
	9.5	PERCENT BOUND IN SPECIES #5001401	NaHCO3 AQ
	88.8	PERCENT BOUND IN SPECIES #3301400	HCO3 -
Na+1			
	93.7	PERCENT BOUND IN SPECIES # 500	Na+1
	1.8	PERCENT BOUND IN SPECIES #5001400	NaCO3 -
	4.5	PERCENT BOUND IN SPECIES #5001401	NaHCO3 AQ
CO3-2			
	1.8	PERCENT BOUND IN SPECIES # 140	CO3-2
	3.6	PERCENT BOUND IN SPECIES #5001400	NaCO3 -
	9.0	PERCENT BOUND IN SPECIES #5001401	NaHCO3 AQ

	84.7	PERCENT BOUND IN SPECIES #3301400 HCO3 -
Ca+2	54.9	PERCENT BOUND IN SPECIES # 150 Ca+2
	27.2	PERCENT BOUND IN SPECIES #1501400 CaHCO3 +
	17.9	PERCENT BOUND IN SPECIES #1501401 CaCO3 AQ
Cl-1	100.0	PERCENT BOUND IN SPECIES # 180 Cl-1
Mg+2	56.8	PERCENT BOUND IN SPECIES # 460 Mg+2
	12.4	PERCENT BOUND IN SPECIES #4601400 MgCO3 AQ
	30.8	PERCENT BOUND IN SPECIES #4601401 MgHCO3 +
NO3-1	100.0	PERCENT BOUND IN SPECIES # 492 NO3-1
H2O	98.9	PERCENT BOUND IN SPECIES #3300020 OH-

----------- EQUILIBRATED MASS DISTRIBUTION -----------

IDX	NAME	DISSOLVED		SORBED		PRECIPITATED	
		MOL/KG	PERCENT	MOL/KG	PERCENT	MOL/KG	PERCENT
330	H+1	2.070E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
500	Na+1	4.340E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
140	CO3-2	2.170E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
150	Ca+2	2.500E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
180	Cl-1	5.000E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
460	Mg+2	4.200E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
492	NO3-1	2.070E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
2	H2O	2.380E-06	100.0	0.000E-01	0.0	0.000E-01	0.0

Charge Balance: SPECIATED

Sum of CATIONS = 4.076E-01 Sum of ANIONS 4.067E-01

PERCENT DIFFERENCE = 1.035E-01 (ANIONS - CATIONS)/(ANIONS + CATIONS)

EQUILIBRIUM IONIC STRENGTH (m) = 4.114E-01

EQUILIBRIUM pH = 8.196

DATE ID NUMBER: 940826
TIME ID NUMBER: 15060816

Saturation indices and stoichiometry of all minerals

ID #	NAME	Sat. Index	Stoichiometry in [brackets]		
5015000	ARAGONITE	0.875	[1.000] 150	[1.000] 140	
5046000	ARTINITE	-4.628	[-2.000] 330	[2.000] 460	[1.000] 140
			[5.000] 2		
2046000	BRUCITE	-4.573	[1.000] 460	[2.000] 2	[-2.000] 330
5015001	CALCITE	1.011	[1.000] 150	[1.000] 140	
5015002	DOLOMITE	2.319	[1.000] 150	[1.000] 460	[2.000] 140
4150000	HALITE	-5.575	[1.000] 500	[1.000] 180	
5015003	HUNTITE	0.870	[3.000] 460	[1.000] 150	[4.000] 140
5046001	HYDRMAGNESIT	-7.904	[5.000] 460	[4.000] 140	[-2.000] 330
			[6.000] 2		
5046002	MAGNESITE	0.814	[1.000] 460	[1.000] 140	
3050000	NATRON	-2.898	[2.000] 500	[1.000] 140	[10.000] 2
5046003	NESQUEHONITE	-1.619	[1.000] 460	[1.000] 140	[3.000] 2
5050001	THERMONATR	-4.217	[2.000] 500	[1.000] 140	[1.000] 2
2015000	LIME	-20.760	[-2.000] 330	[1.000] 150	[1.000] 2
2015001	PORTLANDITE	-10.685	[-2.000] 330	[1.000] 150	[2.000] 2
2046001	PERICLASE	-9.258	[-2.000] 330	[1.000] 460	[1.000] 2

PC MINTEQA2 v3.10   DATE OF CALCULATIONS: 26-AUG-94 TIME: 15: 2:35

Run 4 - 10 g/l Na; 10 mg/l Ca and Mg; sample 5; pH 7,2
add HNO3

Type I - COMPONENTS AS SPECIES IN SOLUTION

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
330	H+1	9.201E-08	6.521E-08	-7.18569	0.70872	0.150
500	Na+1	4.138E-01	2.933E-01	-0.53273	0.70872	0.150
140	CO3-2	3.688E-04	9.303E-05	-4.03137	0.25228	0.598
150	Ca+2	1.651E-04	4.166E-05	-4.38032	0.25228	0.598
180	Cl-1	5.000E-04	3.544E-04	-3.45056	0.70872	0.150
460	Mg+2	2.710E-04	6.838E-05	-4.16509	0.25228	0.598
492	NO3-1	2.329E-01	1.651E-01	-0.78236	0.70872	0.150

Type II - OTHER SPECIES IN SOLUTION OR ADSORBED

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
3301401	H2CO3 AQ	1.703E-02	1.874E-02	-1.72726	1.10035	16.634
3300020	OH-	2.299E-07	1.630E-07	-6.78794	0.70872	-13.816
4603300	MgOH +	2.603E-09	1.845E-09	-8.73400	0.70872	-11.597
4601400	MgCO3 AQ	5.603E-06	6.165E-06	-5.21005	1.10035	2.945
4601401	MgHCO3 +	1.434E-04	1.016E-04	-3.99310	0.70872	11.539
1503300	CaOH +	2.422E-10	1.717E-10	-9.76535	0.70872	-12.413
1501400	CaHCO3 +	7.976E-05	5.653E-05	-4.24774	0.70872	11.499
1501401	CaCO3 AQ	5.122E-06	5.636E-06	-5.24903	1.10035	3.121
5001400	NaCO3 -	7.504E-04	5.318E-04	-3.27426	0.70872	1.439
5001401	NaHCO3 AQ	1.944E-02	2.139E-02	-1.66979	1.10035	10.038
3301400	HCO3 -	1.792E-01	1.270E-01	-0.89624	0.70872	10.470

Type III - SPECIES WITH FIXED ACTIVITY

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
2	H2O	-2.328E-07	-6.633	0.008	0.000

Type VI - EXCLUDED SPECIES (not included in mole balance)

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
3301403	CO2 (g)	5.811E-01	-0.236	18.159	-0.530

PERCENTAGE DISTRIBUTION OF COMPONENTS AMONG
TYPE I and TYPE II (dissolved and adsorbed) species

H+1

14.6 PERCENT BOUND IN SPECIES #3301401 H2CO3 AQ

8.3 PERCENT BOUND IN SPECIES #5001401 NaHCO3 AQ

76.9 PERCENT BOUND IN SPECIES #3301400 HCO3 -

Na+1

95.3 PERCENT BOUND IN SPECIES # 500 Na+1

4.5 PERCENT BOUND IN SPECIES #5001401 NaHCO3 AQ

CO3-2

7.8 PERCENT BOUND IN SPECIES #3301401 H2CO3 AQ

9.0 PERCENT BOUND IN SPECIES #5001401 NaHCO3 AQ

82.6 PERCENT BOUND IN SPECIES #3301400 HCO3 -

Ca+2			
	66.0	PERCENT BOUND IN SPECIES # 150	Ca+2
	31.9	PERCENT BOUND IN SPECIES #1501400	CaHCO3 +
	2.0	PERCENT BOUND IN SPECIES #1501401	CaCO3 AQ
Cl-1			
	100.0	PERCENT BOUND IN SPECIES # 180	Cl-1
Mg+2			
	64.5	PERCENT BOUND IN SPECIES # 460	Mg+2
	1.3	PERCENT BOUND IN SPECIES #4601400	MgCO3 AQ
	34.1	PERCENT BOUND IN SPECIES #4601401	MgHCO3 +
NO3-1			
	100.0	PERCENT BOUND IN SPECIES # 492	NO3-1
H2O			
	98.8	PERCENT BOUND IN SPECIES #3300020	OH-
	1.1	PERCENT BOUND IN SPECIES #4603300	MgOH +

----------- EQUILIBRATED MASS DISTRIBUTION -----------

IDX	NAME	DISSOLVED MOL/KG	DISSOLVED PERCENT	SORBED MOL/KG	SORBED PERCENT	PRECIPITATED MOL/KG	PRECIPITATED PERCENT
330	H+1	2.329E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
500	Na+1	4.340E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
140	CO3-2	2.170E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
150	Ca+2	2.500E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
180	Cl-1	5.000E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
460	Mg+2	4.200E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
492	NO3-1	2.329E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
2	H2O	2.328E-07	100.0	0.000E-01	0.0	0.000E-01	0.0

Charge Balance: SPECIATED

Sum of CATIONS = 4.149E-01 Sum of ANIONS 4.141E-01

PERCENT DIFFERENCE = 1.013E-01 (ANIONS - CATIONS)/(ANIONS + CATIONS)

EQUILIBRIUM IONIC STRENGTH (m) = 4.153E-01

EQUILIBRIUM pH = 7.186

DATE ID NUMBER: 940826
TIME ID NUMBER: 15023862

Saturation indices and stoichiometry of all minerals

ID #	NAME	Sat. Index	Stoichiometry in [brackets]					
5015000	ARAGONITE	-0.066	[1.000]	150	[1.000]	140		
5046000	ARTINITE	-7.561	[-2.000]	330	[2.000]	460	[1.000]	140
			[5.000]	2				
2046000	BRUCITE	-6.539	[1.000]	460	[2.000]	2	[-2.000]	330
5015001	CALCITE	0.070	[1.000]	150	[1.000]	140		
5015002	DOLOMITE	0.412	[1.000]	150	[1.000]	460	[2.000]	140
4150000	HALITE	-5.568	[1.000]	500	[1.000]	180		
5015003	HUNTITE	-2.970	[3.000]	460	[1.000]	150	[4.000]	140
5046001	HYDRMAGNESIT	-13.736	[5.000]	460	[4.000]	140	[-2.000]	330
			[6.000]	2				
5046002	MAGNESITE	-0.152	[1.000]	460	[1.000]	140		
3050000	NATRON	-3.908	[2.000]	500	[1.000]	140	[10.000]	2
5046003	NESQUEHONITE	-2.586	[1.000]	460	[1.000]	140	[3.000]	2
5050001	THERMONATR	-5.223	[2.000]	500	[1.000]	140	[1.000]	2
2015000	LIME	-22.701	[-2.000]	330	[1.000]	150	[1.000]	2
2015001	PORTLANDITE	-12.625	[-2.000]	330	[1.000]	150	[2.000]	2
2046001	PERICLASE	-11.223	[-2.000]	330	[1.000]	460	[1.000]	2

Run 5 - 10 g/l Na; 10 mg/l Ca and Mg; sample 1; pH 11
add HNO3

Type I - COMPONENTS AS SPECIES IN SOLUTION

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
330	H+1	1.409E-11	1.000E-11	-10.99991	0.70982	0.149
500	Na+1	3.069E-01	2.178E-01	-0.66187	0.70982	0.149
150	Ca+2	1.899E-06	4.820E-07	-6.31697	0.25387	0.595
180	Cl-1	5.000E-04	3.549E-04	-3.44988	0.70982	0.149
460	Mg+2	5.386E-05	1.367E-05	-4.86417	0.25387	0.595
969	EDTA-4	1.184E-08	4.917E-11	-10.30830	0.00415	2.382
140	CO3-2	8.337E-02	2.117E-02	-1.67436	0.25387	0.595
492	NO3-1	5.239E-03	3.719E-03	-2.42960	0.70982	0.149

Type II - OTHER SPECIES IN SOLUTION OR ADSORBED

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
5009690	Na EDTA	7.404E-08	3.387E-09	-8.47017	0.04575	3.840
3300020	OH-	1.508E-03	1.071E-03	-2.97032	0.70982	-13.816
4603300	MgOH +	3.415E-06	2.424E-06	-5.61546	0.70982	-11.597
4601400	MgCO3 AQ	2.563E-04	2.805E-04	-3.55213	1.09422	2.947
4601401	MgHCO3 +	9.987E-07	7.089E-07	-6.14939	0.70982	11.538
1503300	CaOH +	1.839E-08	1.305E-08	-7.88437	0.70982	-12.414
1501400	CaHCO3 +	3.216E-08	2.282E-08	-7.64160	0.70982	11.498
1501401	CaCO3 AQ	1.356E-05	1.484E-05	-4.82868	1.09422	3.124
5001400	NaCO3 -	1.266E-01	8.987E-02	-1.04640	0.70982	1.439
5001401	NaHCO3 AQ	5.067E-04	5.544E-04	-3.25614	1.09422	10.041
3301400	HCO3 -	6.243E-03	4.431E-03	-2.35346	0.70982	10.470
3301401	H2CO3 AQ	9.167E-08	1.003E-07	-6.99869	1.09422	16.636
3309691	EDTAH	9.805E-11	4.485E-12	-11.34821	0.04575	11.300
3309692	EDTAH2	3.143E-16	7.978E-17	-16.09812	0.25387	16.805
3309693	EDTAH3	5.021E-25	3.564E-25	-24.44803	0.70982	19.009
3309694	EDTAH4	3.828E-34	4.189E-34	-33.37794	1.09422	20.891
3309695	EDTA H5	2.018E-42	1.433E-42	-41.84385	0.70982	23.613
1509690	Ca EDTA	2.345E-04	5.953E-05	-4.22527	0.25387	12.995
1509691	CaHEDTA	3.339E-12	2.370E-12	-11.62518	0.70982	16.149
4609690	Mg EDTA	1.054E-04	2.676E-05	-4.57247	0.25387	11.195
4609691	MgHEDTA	1.193E-11	8.465E-12	-11.07238	0.70982	15.249

Type III - SPECIES WITH FIXED ACTIVITY

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
2	H2O	-1.512E-03	-2.820	0.005	0.000

Type VI - EXCLUDED SPECIES (not included in mole balance)

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
3301403	CO2 (g)	3.086E-06	-5.511	18.159	-0.530

PERCENTAGE DISTRIBUTION OF COMPONENTS AMONG
TYPE I and TYPE II (dissolved and adsorbed) species

H+1
- 9.7 PERCENT BOUND IN SPECIES #5001401 NaHCO3 AQ
- 119.2 PERCENT BOUND IN SPECIES #3301400 HCO3 -

Na+1
- 70.7 PERCENT BOUND IN SPECIES # 500 Na+1
- 29.2 PERCENT BOUND IN SPECIES #5001400 NaCO3 -

Ca+2
- 5.4 PERCENT BOUND IN SPECIES #1501401 CaCO3 AQ
- 93.8 PERCENT BOUND IN SPECIES #1509690 Ca EDTA

Cl-1
- 100.0 PERCENT BOUND IN SPECIES # 180 Cl-1

Mg+2
- 12.8 PERCENT BOUND IN SPECIES # 460 Mg+2
- 61.0 PERCENT BOUND IN SPECIES #4601400 MgCO3 AQ
- 25.1 PERCENT BOUND IN SPECIES #4609690 Mg EDTA

EDTA-4
- 69.0 PERCENT BOUND IN SPECIES #1509690 Ca EDTA
- 31.0 PERCENT BOUND IN SPECIES #4609690 Mg EDTA

CO3-2
- 38.4 PERCENT BOUND IN SPECIES # 140 CO3-2
- 58.3 PERCENT BOUND IN SPECIES #5001400 NaCO3 -
- 2.9 PERCENT BOUND IN SPECIES #3301400 HCO3 -

NO3-1
- 100.0 PERCENT BOUND IN SPECIES # 492 NO3-1

H2O
- 99.8 PERCENT BOUND IN SPECIES #3300020 OH-

----------- EQUILIBRATED MASS DISTRIBUTION -----------

IDX	NAME	DISSOLVED		SORBED		PRECIPITATED	
		MOL/KG	PERCENT	MOL/KG	PERCENT	MOL/KG	PERCENT
330	H+1	5.239E-03	100.0	0.000E-01	0.0	0.000E-01	0.0
500	Na+1	4.340E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
150	Ca+2	2.500E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
180	Cl-1	5.000E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
460	Mg+2	4.200E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
969	EDTA-4	3.400E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
140	CO3-2	2.170E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
492	NO3-1	5.239E-03	100.0	0.000E-01	0.0	0.000E-01	0.0
2	H2O	1.512E-03	100.0	0.000E-01	0.0	0.000E-01	0.0

Charge Balance: SPECIATED

Sum of CATIONS = 3.070E-01 Sum of ANIONS 3.075E-01

PERCENT DIFFERENCE = 8.455E-02 (ANIONS - CATIONS)/(ANIONS + CATIONS)

EQUILIBRIUM IONIC STRENGTH (m) = 3.910E-01

EQUILIBRIUM pH = 11.000

DATE ID NUMBER: 940826
TIME ID NUMBER: 16144158

Saturation indices and stoichiometry of all minerals

ID #	NAME	Sat. Index	Stoichiometry in [brackets]					
5015000	ARAGONITE	0.354	[1.000]	150	[1.000]	140		
5046000	ARTINITE	1.043	[-2.000]	330	[2.000]	460	[1.000]	140
			[5.000]	2				
2046000	BRUCITE	0.397	[1.000]	460	[2.000]	2	[-2.000]	330
5015001	CALCITE	0.490	[1.000]	150	[1.000]	140		
5015002	DOLOMITE	2.490	[1.000]	150	[1.000]	460	[2.000]	140
4150000	HALITE	-5.696	[1.000]	500	[1.000]	180		
5015003	HUNTITE	2.424	[3.000]	460	[1.000]	150	[4.000]	140
5046001	HYDRMAGNESIT	-0.154	[5.000]	460	[4.000]	140	[-2.000]	330
			[6.000]	2				
5046002	MAGNESITE	1.506	[1.000]	460	[1.000]	140		
3050000	NATRON	-1.775	[2.000]	500	[1.000]	140	[10.000]	2
5046003	NESQUEHONITE	-0.918	[1.000]	460	[1.000]	140	[3.000]	2
5050001	THERMONATR	-3.121	[2.000]	500	[1.000]	140	[1.000]	2
2015000	LIME	-17.006	[-2.000]	330	[1.000]	150	[1.000]	2
2015001	PORTLANDITE	-6.927	[-2.000]	330	[1.000]	150	[2.000]	2
2046001	PERICLASE	-4.291	[-2.000]	330	[1.000]	460	[1.000]	2

Run 5 - 10 g/l Na; 10 mg/l Ca and Mg; 0,1 g/l EDTA; sample 2; pH 10,0
add HNO3

Type I - COMPONENTS AS SPECIES IN SOLUTION

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
330	H+1	1.412E-10	1.002E-10	-9.99892	0.70980	0.149
500	Na+1	3.277E-01	2.326E-01	-0.63344	0.70980	0.149
140	CO3-2	6.307E-02	1.601E-02	-1.79565	0.25383	0.595
150	Ca+2	2.345E-06	5.951E-07	-6.22540	0.25383	0.595
180	Cl-1	5.000E-04	3.549E-04	-3.44990	0.70980	0.149
460	Mg+2	6.633E-05	1.684E-05	-4.77375	0.25383	0.595
969	EDTA-4	9.600E-09	3.985E-11	-10.39956	0.00415	2.382
492	NO3-1	5.130E-02	3.641E-02	-1.43875	0.70980	0.149

Type II - OTHER SPECIES IN SOLUTION OR ADSORBED

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
5009690	Na EDTA	6.409E-08	2.931E-09	-8.53300	0.04573	3.840
3300020	OH-	1.503E-04	1.067E-04	-3.97199	0.70980	-13.816
4603300	MgOH +	4.189E-07	2.974E-07	-6.52672	0.70980	-11.597
4601400	MgCO3 AQ	2.387E-04	2.612E-04	-3.58300	1.09435	2.947
4601401	MgHCO3 +	9.324E-06	6.618E-06	-5.17928	0.70980	11.538
1503300	CaOH +	2.261E-09	1.605E-09	-8.79448	0.70980	-12.414
1501400	CaHCO3 +	3.010E-07	2.136E-07	-6.67034	0.70980	11.499
1501401	CaCO3 AQ	1.266E-05	1.385E-05	-4.85840	1.09435	3.124
5001400	NaCO3 -	1.022E-01	7.257E-02	-1.13926	0.70980	1.439
5001401	NaHCO3 AQ	4.100E-03	4.487E-03	-2.34801	1.09435	10.041
3301400	HCO3 -	4.733E-02	3.359E-02	-1.47376	0.70980	10.470
3301401	H2CO3 AQ	6.964E-06	7.621E-06	-5.11800	1.09435	16.636
3309691	EDTAH	7.967E-10	3.643E-11	-10.43848	0.04573	11.300
3309692	EDTAH2	2.559E-14	6.495E-15	-14.18740	0.25383	16.805
3309693	EDTAH3	4.098E-22	2.909E-22	-21.53632	0.70980	19.009
3309694	EDTAH4	3.130E-30	3.426E-30	-29.46525	1.09435	20.891
3309695	EDTA H5	1.655E-37	1.174E-37	-36.93017	0.70980	23.613
1509690	Ca EDTA	2.347E-04	5.957E-05	-4.22497	0.25383	12.995
1509691	CaHEDTA	3.349E-11	2.377E-11	-10.62389	0.70980	16.149
4609690	Mg EDTA	1.052E-04	2.671E-05	-4.57331	0.25383	11.195
4609691	MgHEDTA	1.193E-10	8.468E-11	-10.07223	0.70980	15.249

Type III - SPECIES WITH FIXED ACTIVITY

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
2	H2O	-1.507E-04	-3.822	0.006	0.000

Type VI - EXCLUDED SPECIES (not included in mole balance)

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
3301403	CO2 (g)	2.349E-04	-3.629	18.159	-0.530

PERCENTAGE DISTRIBUTION OF COMPONENTS AMONG
TYPE I and TYPE II (dissolved and adsorbed) species

```
H+1
        8.0     PERCENT BOUND IN SPECIES #5001401   NaHCO3 AQ
       92.3     PERCENT BOUND IN SPECIES #3301400   HCO3 -
Na+1
       75.5     PERCENT BOUND IN SPECIES #    500   Na+1
       23.6     PERCENT BOUND IN SPECIES #5001400   NaCO3 -
CO3-2
       29.1     PERCENT BOUND IN SPECIES #    140   CO3-2
       47.1     PERCENT BOUND IN SPECIES #5001400   NaCO3 -
        1.9     PERCENT BOUND IN SPECIES #5001401   NaHCO3 AQ
       21.8     PERCENT BOUND IN SPECIES #3301400   HCO3 -
Ca+2
        5.1     PERCENT BOUND IN SPECIES #1501401   CaCO3 AQ
       93.9     PERCENT BOUND IN SPECIES #1509690   Ca EDTA
Cl-1
      100.0     PERCENT BOUND IN SPECIES #    180   Cl-1
Mg+2
       15.8     PERCENT BOUND IN SPECIES #    460   Mg+2
       56.8     PERCENT BOUND IN SPECIES #4601400   MgCO3 AQ
        2.2     PERCENT BOUND IN SPECIES #4601401   MgHCO3 +
       25.1     PERCENT BOUND IN SPECIES #4609690   Mg EDTA
EDTA-4
       69.0     PERCENT BOUND IN SPECIES #1509690   Ca EDTA
       31.0     PERCENT BOUND IN SPECIES #4609690   Mg EDTA
NO3-1
      100.0     PERCENT BOUND IN SPECIES #    492   NO3-1
H2O
       99.7     PERCENT BOUND IN SPECIES #3300020   OH-
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----------- EQUILIBRATED MASS DISTRIBUTION -----------

IDX	NAME	DISSOLVED		SORBED		PRECIPITATED	
		MOL/KG	PERCENT	MOL/KG	PERCENT	MOL/KG	PERCENT
330	H+1	5.130E-02	100.0	0.000E-01	0.0	0.000E-01	0.0
500	Na+1	4.340E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
140	CO3-2	2.170E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
150	Ca+2	2.500E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
180	Cl-1	5.000E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
460	Mg+2	4.200E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
969	EDTA-4	3.400E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
492	NO3-1	5.130E-02	100.0	0.000E-01	0.0	0.000E-01	0.0
2	H2O	1.507E-04	100.0	0.000E-01	0.0	0.000E-01	0.0

Charge Balance: SPECIATED

Sum of CATIONS = 3.278E-01 Sum of ANIONS 3.283E-01

PERCENT DIFFERENCE = 7.920E-02 (ANIONS - CATIONS)/(ANIONS + CATIONS)

EQUILIBRIUM IONIC STRENGTH (m) = 3.915E-01

EQUILIBRIUM pH = 9.999

DATE ID NUMBER: 940826
TIME ID NUMBER: 16125860

Saturation indices and stoichiometry of all minerals

ID #	NAME	Sat. Index	Stoichiometry in [brackets]					
5015000	ARAGONITE	0.324	[1.000]	150	[1.000]	140		
5046000	ARTINITE	-0.903	[-2.000]	330	[2.000]	460	[1.000]	140
			[5.000]	2				
2046000	BRUCITE	-1.516	[1.000]	460	[2.000]	2	[-2.000]	330
5015001	CALCITE	0.460	[1.000]	150	[1.000]	140		
5015002	DOLOMITE	2.430	[1.000]	150	[1.000]	460	[2.000]	140
4150000	HALITE	-5.668	[1.000]	500	[1.000]	180		
5015003	HUNTITE	2.302	[3.000]	460	[1.000]	150	[4.000]	140
5046001	HYDRMAGNESIT	-2.193	[5.000]	460	[4.000]	140	[-2.000]	330
			[6.000]	2				
5046002	MAGNESITE	1.475	[1.000]	460	[1.000]	140		
3050000	NATRON	-1.846	[2.000]	500	[1.000]	140	[10.000]	2
5046003	NESQUEHONITE	-0.951	[1.000]	460	[1.000]	140	[3.000]	2
5050001	THERMONATR	-3.186	[2.000]	500	[1.000]	140	[1.000]	2
2015000	LIME	-18.917	[-2.000]	330	[1.000]	150	[1.000]	2
2015001	PORTLANDITE	-8.839	[-2.000]	330	[1.000]	150	[2.000]	2
2046001	PERICLASE	-6.203	[-2.000]	330	[1.000]	460	[1.000]	2

Run 5 - 10 g/l Na; 10 mg/l Ca and Mg; sample 3; pH 9
add HNO3

Type I - COMPONENTS AS SPECIES IN SOLUTION

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
330	H+1	1.422E-09	1.008E-09	-8.99639	0.70923	0.149
500	Na+1	3.827E-01	2.714E-01	-0.56633	0.70923	0.149
140	CO3-2	1.938E-02	4.903E-03	-2.30951	0.25302	0.597
150	Ca+2	4.518E-06	1.143E-06	-5.94187	0.25302	0.597
180	Cl-1	5.000E-04	3.546E-04	-3.45024	0.70923	0.149
460	Mg+2	1.251E-04	3.165E-05	-4.49958	0.25302	0.597
969	EDTA-4	5.080E-09	2.082E-11	-10.68157	0.00410	2.387
492	NO3-1	1.611E-01	1.143E-01	-0.94212	0.70923	0.149

Type II - OTHER SPECIES IN SOLUTION OR ADSORBED

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
5009690	Na EDTA	3.936E-08	1.787E-09	-8.74791	0.04540	3.843
3300020	OH-	1.490E-05	1.056E-05	-4.97617	0.70923	-13.816
4603300	MgOH +	7.807E-08	5.537E-08	-7.25672	0.70923	-11.597
4601400	MgCO3 AQ	1.371E-04	1.504E-04	-3.82269	1.09727	2.946
4601401	MgHCO3 +	5.405E-05	3.833E-05	-4.41643	0.70923	11.538
1503300	CaOH +	4.306E-10	3.054E-10	-9.51512	0.70923	-12.413
1501400	CaHCO3 +	1.783E-06	1.264E-06	-5.89813	0.70923	11.499
1501401	CaCO3 AQ	7.430E-06	8.152E-06	-5.08873	1.09727	3.122
5001400	NaCO3 -	3.658E-02	2.594E-02	-1.58601	0.70923	1.439
5001401	NaHCO3 AQ	1.470E-02	1.613E-02	-1.79223	1.09727	10.040
3301400	HCO3 -	1.459E-01	1.035E-01	-0.98509	0.70923	10.470
3301401	H2CO3 AQ	2.152E-04	2.362E-04	-3.62679	1.09727	16.635
3309691	EDTAH	4.216E-09	1.914E-10	-9.71796	0.04540	11.303
3309692	EDTAH2	1.357E-12	3.433E-13	-12.46435	0.25302	16.807
3309693	EDTAH3	2.180E-19	1.546E-19	-18.81074	0.70923	19.009
3309694	EDTAH4	1.669E-26	1.832E-26	-25.73713	1.09727	20.890
3309695	EDTA H5	8.906E-33	6.317E-33	-32.19952	0.70923	23.613
1509690	Ca EDTA	2.363E-04	5.978E-05	-4.22344	0.25302	12.997
1509691	CaHEDTA	3.384E-10	2.400E-10	-9.61983	0.70923	16.149
4609690	Mg EDTA	1.037E-04	2.623E-05	-4.58115	0.25302	11.197
4609691	MgHEDTA	1.179E-09	8.365E-10	-9.07754	0.70923	15.249

Type III - SPECIES WITH FIXED ACTIVITY

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
2	H2O	-1.497E-05	-4.825	0.007	0.000

Type VI - EXCLUDED SPECIES (not included in mole balance)

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
3301403	CO2 (g)	7.306E-03	-2.136	18.159	-0.530

PERCENTAGE DISTRIBUTION OF COMPONENTS AMONG
TYPE I and TYPE II (dissolved and adsorbed) species

H+1
9.1 PERCENT BOUND IN SPECIES #5001401 NaHCO3 AQ
90.6 PERCENT BOUND IN SPECIES #3301400 HCO3 -

Na+1
88.2 PERCENT BOUND IN SPECIES # 500 Na+1
8.4 PERCENT BOUND IN SPECIES #5001400 NaCO3 -
3.4 PERCENT BOUND IN SPECIES #5001401 NaHCO3 AQ

CO3-2
8.9 PERCENT BOUND IN SPECIES # 140 CO3-2
16.9 PERCENT BOUND IN SPECIES #5001400 NaCO3 -
6.8 PERCENT BOUND IN SPECIES #5001401 NaHCO3 AQ
67.2 PERCENT BOUND IN SPECIES #3301400 HCO3 -

Ca+2
1.8 PERCENT BOUND IN SPECIES # 150 Ca+2
3.0 PERCENT BOUND IN SPECIES #1501401 CaCO3 AQ
94.5 PERCENT BOUND IN SPECIES #1509690 Ca EDTA

Cl-1
100.0 PERCENT BOUND IN SPECIES # 180 Cl-1

Mg+2
29.8 PERCENT BOUND IN SPECIES # 460 Mg+2
32.6 PERCENT BOUND IN SPECIES #4601400 MgCO3 AQ
12.9 PERCENT BOUND IN SPECIES #4601401 MgHCO3 +
24.7 PERCENT BOUND IN SPECIES #4609690 Mg EDTA

EDTA-4
69.5 PERCENT BOUND IN SPECIES #1509690 Ca EDTA
30.5 PERCENT BOUND IN SPECIES #4609690 Mg EDTA

NO3-1
100.0 PERCENT BOUND IN SPECIES # 492 NO3-1

H2O
99.5 PERCENT BOUND IN SPECIES #3300020 OH-

----------- EQUILIBRATED MASS DISTRIBUTION -----------

IDX	NAME	DISSOLVED		SORBED		PRECIPITATED	
		MOL/KG	PERCENT	MOL/KG	PERCENT	MOL/KG	PERCENT
330	H+1	1.611E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
500	Na+1	4.340E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
140	CO3-2	2.170E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
150	Ca+2	2.500E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
180	Cl-1	5.000E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
460	Mg+2	4.200E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
969	EDTA-4	3.400E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
492	NO3-1	1.611E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
2	H2O	1.497E-05	100.0	0.000E-01	0.0	0.000E-01	0.0

Charge Balance: SPECIATED

Sum of CATIONS = 3.830E-01 Sum of ANIONS 3.836E-01

PERCENT DIFFERENCE = 6.783E-02 (ANIONS - CATIONS)/(ANIONS + CATIONS)

EQUILIBRIUM IONIC STRENGTH (m) = 4.031E-01

EQUILIBRIUM pH = 8.996

DATE ID NUMBER: 940826
TIME ID NUMBER: 16105090

Saturation indices and stoichiometry of all minerals

ID #	NAME	Sat. Index	Stoichiometry in [brackets]		
5015000	ARAGONITE	0.094	[1.000] 150	[1.000] 140	
5046000	ARTINITE	-2.882	[-2.000] 330	[2.000] 460	[1.000] 140
			[5.000] 2		
2046000	BRUCITE	-3.250	[1.000] 460	[2.000] 2	[-2.000] 330
5015001	CALCITE	0.230	[1.000] 150	[1.000] 140	
5015002	DOLOMITE	1.960	[1.000] 150	[1.000] 460	[2.000] 140
4150000	HALITE	-5.601	[1.000] 500	[1.000] 180	
5015003	HUNTITE	1.352	[3.000] 460	[1.000] 150	[4.000] 140
5046001	HYDRMAGNESIT	-4.893	[5.000] 460	[4.000] 140	[-2.000] 330
			[6.000] 2		
5046002	MAGNESITE	1.235	[1.000] 460	[1.000] 140	
3050000	NATRON	-2.242	[2.000] 500	[1.000] 140	[10.000] 2
5046003	NESQUEHONITE	-1.196	[1.000] 460	[1.000] 140	[3.000] 2
5050001	THERMONATR	-3.568	[2.000] 500	[1.000] 140	[1.000] 2
2015000	LIME	-20.640	[-2.000] 330	[1.000] 150	[1.000] 2
2015001	PORTLANDITE	-10.563	[-2.000] 330	[1.000] 150	[2.000] 2
2046001	PERICLASE	-7.936	[-2.000] 330	[1.000] 460	[1.000] 2

Run 5 - 10 g/l Na; 10 mg/l Ca and Mg; 0,1 g/l EDTA; sample 4; pH 7.8
add HNO3

Type I - COMPONENTS AS SPECIES IN SOLUTION

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
330	H+1	2.280E-08	1.616E-08	-7.79149	0.70879	0.149
500	Na+1	4.107E-01	2.911E-01	-0.53601	0.70879	0.149
140	CO3-2	1.557E-03	3.929E-04	-3.40571	0.25238	0.598
150	Ca+2	7.200E-06	1.817E-06	-5.74063	0.25238	0.598
180	Cl-1	5.000E-04	3.544E-04	-3.45051	0.70879	0.149
460	Mg+2	1.939E-04	4.894E-05	-4.31030	0.25238	0.598
969	EDTA-4	3.246E-09	1.317E-11	-10.88035	0.00406	2.392
492	NO3-1	2.167E-01	1.536E-01	-0.81363	0.70879	0.149

Type II - OTHER SPECIES IN SOLUTION OR ADSORBED

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
5009690	Na EDTA	2.685E-08	1.212E-09	-8.91636	0.04515	3.845
3300020	OH-	9.281E-07	6.578E-07	-6.18191	0.70879	-13.816
4603300	MgOH +	7.521E-09	5.331E-09	-8.27318	0.70879	-11.597
4601400	MgCO3 AQ	1.694E-05	1.864E-05	-4.72961	1.09990	2.945
4601401	MgHCO3 +	1.074E-04	7.613E-05	-4.11845	0.70879	11.539
1503300	CaOH +	4.264E-11	3.023E-11	-10.51962	0.70879	-12.413
1501400	CaHCO3 +	3.642E-06	2.581E-06	-5.58818	0.70879	11.499
1501401	CaCO3 AQ	9.440E-07	1.038E-06	-5.98368	1.09990	3.121
5001400	NaCO3 -	3.145E-03	2.229E-03	-2.65188	0.70879	1.439
5001401	NaHCO3 AQ	2.020E-02	2.222E-02	-1.65321	1.09990	10.039
3301400	HCO3 -	1.875E-01	1.329E-01	-0.87638	0.70879	10.470
3301401	H2CO3 AQ	4.420E-03	4.862E-03	-2.31319	1.09990	16.634
3309691	EDTAH	4.301E-08	1.942E-09	-8.71184	0.04515	11.305
3309692	EDTAH2	2.211E-10	5.581E-11	-10.25332	0.25238	16.808
3309693	EDTAH3	5.684E-16	4.029E-16	-15.39481	0.70879	19.009
3309694	EDTAH4	6.956E-22	7.651E-22	-21.11630	1.09990	20.889
3309695	EDTA H5	5.966E-27	4.229E-27	-26.37379	0.70879	23.613
1509690	Ca EDTA	2.382E-04	6.012E-05	-4.22098	0.25238	12.998
1509691	CaHEDTA	5.458E-09	3.868E-09	-8.41247	0.70879	16.149
4609690	Mg EDTA	1.017E-04	2.567E-05	-4.59065	0.25238	11.198
4609691	MgHEDTA	1.851E-08	1.312E-08	-7.88213	0.70879	15.249

Type III - SPECIES WITH FIXED ACTIVITY

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
2	H2O	-9.356E-07	-6.029	0.008	0.000

Type VI - EXCLUDED SPECIES (not included in mole balance)

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
3301403	CO2 (g)	1.507E-01	-0.822	18.159	-0.530

PERCENTAGE DISTRIBUTION OF COMPONENTS AMONG
TYPE I and TYPE II (dissolved and adsorbed) species

H+1
9.3 PERCENT BOUND IN SPECIES #5001401 NaHCO3 AQ
86.5 PERCENT BOUND IN SPECIES #3301400 HCO3 -
4.1 PERCENT BOUND IN SPECIES #3301401 H2CO3 AQ

Na+1
94.6 PERCENT BOUND IN SPECIES # 500 Na+1
4.7 PERCENT BOUND IN SPECIES #5001401 NaHCO3 AQ

CO3-2
1.4 PERCENT BOUND IN SPECIES #5001400 NaCO3 -
9.3 PERCENT BOUND IN SPECIES #5001401 NaHCO3 AQ
86.4 PERCENT BOUND IN SPECIES #3301400 HCO3 -
2.0 PERCENT BOUND IN SPECIES #3301401 H2CO3 AQ

Ca+2
2.9 PERCENT BOUND IN SPECIES # 150 Ca+2
1.5 PERCENT BOUND IN SPECIES #1501400 CaHCO3 +
95.3 PERCENT BOUND IN SPECIES #1509690 Ca EDTA

Cl-1
100.0 PERCENT BOUND IN SPECIES # 180 Cl-1

Mg+2
46.2 PERCENT BOUND IN SPECIES # 460 Mg+2
4.0 PERCENT BOUND IN SPECIES #4601400 MgCO3 AQ
25.6 PERCENT BOUND IN SPECIES #4601401 MgHCO3 +
24.2 PERCENT BOUND IN SPECIES #4609690 Mg EDTA

EDTA-4
70.1 PERCENT BOUND IN SPECIES #1509690 Ca EDTA
29.9 PERCENT BOUND IN SPECIES #4609690 Mg EDTA

NO3-1
100.0 PERCENT BOUND IN SPECIES # 492 NO3-1

H2O
99.2 PERCENT BOUND IN SPECIES #3300020 OH-

----------- EQUILIBRATED MASS DISTRIBUTION -----------

IDX	NAME	DISSOLVED		SORBED		PRECIPITATED	
		MOL/KG	PERCENT	MOL/KG	PERCENT	MOL/KG	PERCENT
330	H+1	2.167E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
500	Na+1	4.340E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
140	CO3-2	2.170E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
150	Ca+2	2.500E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
180	Cl-1	5.000E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
460	Mg+2	4.200E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
969	EDTA-4	3.400E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
492	NO3-1	2.167E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
2	H2O	9.356E-07	100.0	0.000E-01	0.0	0.000E-01	0.0

Charge Balance: SPECIATED

Sum of CATIONS = 4.112E-01 Sum of ANIONS 4.117E-01

PERCENT DIFFERENCE = 6.320E-02 (ANIONS - CATIONS)/(ANIONS + CATIONS)

EQUILIBRIUM IONIC STRENGTH (m) = 4.135E-01

EQUILIBRIUM pH = 7.791

DATE ID NUMBER: 940826
TIME ID NUMBER: 16085660

Saturation indices and stoichiometry of all minerals

ID #	NAME	Sat. Index	Stoichiometry in [brackets]					
5015000	ARAGONITE	-0.801	[1.000]	150	[1.000]	140		
5046000	ARTINITE	-6.013	[-2.000]	330	[2.000]	460	[1.000]	140
			[5.000]	2				
2046000	BRUCITE	-5.472	[1.000]	460	[2.000]	2	[-2.000]	330
5015001	CALCITE	-0.665	[1.000]	150	[1.000]	140		
5015002	DOLOMITE	0.158	[1.000]	150	[1.000]	460	[2.000]	140
4150000	HALITE	-5.571	[1.000]	500	[1.000]	180		
5015003	HUNTITE	-2.263	[3.000]	460	[1.000]	150	[4.000]	140
5046001	HYDRMAGNESIT	-10.746	[5.000]	460	[4.000]	140	[-2.000]	330
			[6.000]	2				
5046002	MAGNESITE	0.328	[1.000]	460	[1.000]	140		
3050000	NATRON	-3.286	[2.000]	500	[1.000]	140	[10.000]	2
5046003	NESQUEHONITE	-2.105	[1.000]	460	[1.000]	140	[3.000]	2
5050001	THERMONATR	-4.604	[2.000]	500	[1.000]	140	[1.000]	2
2015000	LIME	-22.849	[-2.000]	330	[1.000]	150	[1.000]	2
2015001	PORTLANDITE	-12.774	[-2.000]	330	[1.000]	150	[2.000]	2
2046001	PERICLASE	-10.157	[-2.000]	330	[1.000]	460	[1.000]	2

PC MINTEQA2 v3.10   DATE OF CALCULATIONS: 26-AUG-94   TIME: 16: 6: 9

Run 5 - 10 g/l Na; 10 mg/l Ca and Mg; 0,1 g/l EDTA; sample 5; pH 7,2
add HNO3

Type I - COMPONENTS AS SPECIES IN SOLUTION

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
330	H+1	1.278E-07	9.056E-08	-7.04305	0.70868	0.150
500	Na+1	4.145E-01	2.938E-01	-0.53197	0.70868	0.150
140	CO3-2	2.582E-04	6.512E-05	-4.18630	0.25224	0.598
150	Ca+2	7.779E-06	1.962E-06	-5.70726	0.25224	0.598
180	Cl-1	5.000E-04	3.543E-04	-3.45058	0.70868	0.150
460	Mg+2	2.085E-04	5.258E-05	-4.27916	0.25224	0.598
969	EDTA-4	3.014E-09	1.220E-11	-10.91369	0.00405	2.393
492	NO3-1	2.392E-01	1.695E-01	-0.77079	0.70868	0.150

Type II - OTHER SPECIES IN SOLUTION OR ADSORBED

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
5009690	Na EDTA	2.513E-08	1.133E-09	-8.94566	0.04509	3.846
3300020	OH-	1.655E-07	1.173E-07	-6.93069	0.70868	-13.816
4603300	MgOH +	1.441E-09	1.021E-09	-8.99082	0.70868	-11.597
4601400	MgCO3 AQ	3.015E-06	3.319E-06	-5.47906	1.10057	2.945
4601401	MgHCO3 +	1.072E-04	7.595E-05	-4.11946	0.70868	11.539
1503300	CaOH +	8.213E-12	5.821E-12	-11.23503	0.70868	-12.413
1501400	CaHCO3 +	3.652E-06	2.588E-06	-5.58696	0.70868	11.499
1501401	CaCO3 AQ	1.688E-07	1.858E-07	-6.73090	1.10057	3.121
5001400	NaCO3 -	5.262E-04	3.729E-04	-3.42844	0.70868	1.439
5001401	NaHCO3 AQ	1.893E-02	2.083E-02	-1.68132	1.10057	10.038
3301400	HCO3 -	1.742E-01	1.234E-01	-0.90853	0.70868	10.470
3301401	H2CO3 AQ	2.299E-02	2.530E-02	-1.59690	1.10057	16.634
3309691	EDTAH	2.235E-07	1.008E-08	-7.99673	0.04509	11.306
3309692	EDTAH2	6.433E-09	1.623E-09	-8.78978	0.25224	16.808
3309693	EDTAH3	9.262E-14	6.564E-14	-13.18283	0.70868	19.010
3309694	EDTAH4	6.346E-19	6.984E-19	-18.15588	1.10057	20.888
3309695	EDTA H5	3.052E-23	2.163E-23	-22.66493	0.70868	23.614
1509690	Ca EDTA	2.384E-04	6.013E-05	-4.22094	0.25224	12.998
1509691	CaHEDTA	3.059E-08	2.168E-08	-7.66399	0.70868	16.150
4609690	Mg EDTA	1.012E-04	2.554E-05	-4.59284	0.25224	11.198
4609691	MgHEDTA	1.032E-07	7.313E-08	-7.13589	0.70868	15.250

Type III - SPECIES WITH FIXED ACTIVITY

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
2	H2O	-1.670E-07	-6.777	0.008	0.000

Type VI - EXCLUDED SPECIES (not included in mole balance)

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
3301403	CO2 (g)	7.848E-01	-0.105	18.159	-0.530

PERCENTAGE DISTRIBUTION OF COMPONENTS AMONG
TYPE I and TYPE II (dissolved and adsorbed) species

H+1
7.9 PERCENT BOUND IN SPECIES #5001401 NaHCO3 AQ
72.8 PERCENT BOUND IN SPECIES #3301400 HCO3 -
19.2 PERCENT BOUND IN SPECIES #3301401 H2CO3 AQ

Na+1
95.5 PERCENT BOUND IN SPECIES # 500 Na+1
4.4 PERCENT BOUND IN SPECIES #5001401 NaHCO3 AQ

CO3-2
8.7 PERCENT BOUND IN SPECIES #5001401 NaHCO3 AQ
80.3 PERCENT BOUND IN SPECIES #3301400 HCO3 -
10.6 PERCENT BOUND IN SPECIES #3301401 H2CO3 AQ

Ca+2
3.1 PERCENT BOUND IN SPECIES # 150 Ca+2
1.5 PERCENT BOUND IN SPECIES #1501400 CaHCO3 +
95.3 PERCENT BOUND IN SPECIES #1509690 Ca EDTA

Cl-1
100.0 PERCENT BOUND IN SPECIES # 180 Cl-1

Mg+2
49.6 PERCENT BOUND IN SPECIES # 460 Mg+2
25.5 PERCENT BOUND IN SPECIES #4601401 MgHCO3 +
24.1 PERCENT BOUND IN SPECIES #4609690 Mg EDTA

EDTA-4
70.1 PERCENT BOUND IN SPECIES #1509690 Ca EDTA
29.8 PERCENT BOUND IN SPECIES #4609690 Mg EDTA

NO3-1
100.0 PERCENT BOUND IN SPECIES # 492 NO3-1

H2O
99.1 PERCENT BOUND IN SPECIES #3300020 OH-

----------- EQUILIBRATED MASS DISTRIBUTION -----------

IDX	NAME	DISSOLVED		SORBED		PRECIPITATED	
		MOL/KG	PERCENT	MOL/KG	PERCENT	MOL/KG	PERCENT
330	H+1	2.392E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
500	Na+1	4.340E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
140	CO3-2	2.170E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
150	Ca+2	2.500E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
180	Cl-1	5.000E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
460	Mg+2	4.200E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
969	EDTA-4	3.400E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
492	NO3-1	2.392E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
2	H2O	1.670E-07	100.0	0.000E-01	0.0	0.000E-01	0.0

Charge Balance: SPECIATED

Sum of CATIONS = 4.151E-01 Sum of ANIONS 4.156E-01

PERCENT DIFFERENCE = 6.260E-02 (ANIONS - CATIONS)/(ANIONS + CATIONS)

EQUILIBRIUM IONIC STRENGTH (m) = 4.162E-01

EQUILIBRIUM pH = 7.043

DATE ID NUMBER: 940826
TIME ID NUMBER: 16061275

Saturation indices and stoichiometry of all minerals

ID #	NAME	Sat. Index	Stoichiometry in [brackets]					
5015000	ARAGONITE	-1.548	[1.000]	150	[1.000]	140		
5046000	ARTINITE	-8.230	[-2.000]	330	[2.000]	460	[1.000]	140
			[5.000]	2				
2046000	BRUCITE	-6.939	[1.000]	460	[2.000]	2	[-2.000]	330
5015001	CALCITE	-1.412	[1.000]	150	[1.000]	140		
5015002	DOLOMITE	-1.339	[1.000]	150	[1.000]	460	[2.000]	140
4150000	HALITE	-5.567	[1.000]	500	[1.000]	180		
5015003	HUNTITE	-5.259	[3.000]	460	[1.000]	150	[4.000]	140
5046001	HYDRMAGNESIT	-15.212	[5.000]	460	[4.000]	140	[-2.000]	330
			[6.000]	2				
5046002	MAGNESITE	-0.421	[1.000]	460	[1.000]	140		
3050000	NATRON	-4.062	[2.000]	500	[1.000]	140	[10.000]	2
5046003	NESQUEHONITE	-2.856	[1.000]	460	[1.000]	140	[3.000]	2
5050001	THERMONATR	-5.377	[2.000]	500	[1.000]	140	[1.000]	2
2015000	LIME	-24.313	[-2.000]	330	[1.000]	150	[1.000]	2
2015001	PORTLANDITE	-14.238	[-2.000]	330	[1.000]	150	[2.000]	2
2046001	PERICLASE	-11.623	[-2.000]	330	[1.000]	460	[1.000]	2

Run 4 - 10 g/l Na; 10 mg/l Ca; 10 mg/l Mg; sample 1; pH 11,0
add HNO3; allow ppt

Type I - COMPONENTS AS SPECIES IN SOLUTION

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
330	H+1	1.409E-11	1.000E-11	-10.99989	0.70989	0.149
500	Na+1	3.071E-01	2.180E-01	-0.66158	0.70989	0.149
140	CO3-2	8.317E-02	2.112E-02	-1.67528	0.25396	0.595
150	Ca+2	1.969E-07	5.001E-08	-7.30091	0.25396	0.595
180	Cl-1	5.000E-04	3.549E-04	-3.44986	0.70989	0.149
460	Mg+2	1.684E-06	4.277E-07	-6.36883	0.25396	0.595
492	NO3-1	5.228E-03	3.711E-03	-2.43049	0.70989	0.149

Type II - OTHER SPECIES IN SOLUTION OR ADSORBED

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
3301401	H2CO3 AQ	9.150E-08	1.001E-07	-6.99957	1.09392	16.637
3300020	OH-	1.508E-03	1.071E-03	-2.97033	0.70989	-13.816
4603300	MgOH +	1.068E-07	7.583E-08	-7.12014	0.70989	-11.597
4601400	MgCO3 AQ	8.004E-06	8.756E-06	-5.05772	1.09392	2.947
4601401	MgHCO3 +	3.118E-08	2.213E-08	-7.65496	0.70989	11.538
1503300	CaOH +	1.908E-09	1.354E-09	-8.86833	0.70989	-12.414
1501400	CaHCO3 +	3.329E-09	2.363E-09	-8.62645	0.70989	11.498
1501401	CaCO3 AQ	1.404E-06	1.536E-06	-5.81354	1.09392	3.124
5001400	NaCO3 -	1.264E-01	8.974E-02	-1.04703	0.70989	1.439
5001401	NaHCO3 AQ	5.061E-04	5.537E-04	-3.25675	1.09392	10.041
3301400	HCO3 -	6.229E-03	4.422E-03	-2.35436	0.70989	10.470

Type III - SPECIES WITH FIXED ACTIVITY

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
2	H2O	-1.508E-03	-2.821	0.005	0.000

Type IV - FINITE SOLIDS (present at equilibrium)

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
5015002	DOLOMITE	2.484E-04	-3.605	17.020	8.290
5046002	MAGNESITE	1.618E-04	-3.791	8.044	6.169

Type V - UNDERSATURATED SOLIDS (not present at equilibrium)

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
2046000	BRUCITE	7.806E-02	-1.108	-16.729	25.840
5015001	CALCITE	3.200E-01	-0.495	8.481	2.585
5015000	ARAGONITE	2.339E-01	-0.631	8.345	2.615
4150000	HALITE	2.015E-06	-5.696	-1.584	-0.918
5015003	HUNTITE	8.367E-04	-3.077	30.031	25.760
5046001	HYDRMAGNESIT	2.084E-08	-7.681	8.894	52.210
5046000	ARTINITE	1.078E-02	-1.967	-9.530	28.742
3050000	NATRON	1.678E-02	-1.775	1.272	-15.745
5046003	NESQUEHONITE	3.770E-03	-2.424	5.635	5.789
5050001	THERMONATR	7.560E-04	-3.121	-0.118	2.802
2015000	LIME	1.024E-18	-17.990	-32.684	46.265
2015001	PORTLANDITE	1.228E-08	-7.911	-22.600	30.690
2046001	PERICLASE	1.602E-06	-5.795	-21.421	36.135

Type VI - EXCLUDED SPECIES (not included in mole balance)

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
3301403	CO2 (g)	3.080E-06	-5.511	18.159	-0.530

PERCENTAGE DISTRIBUTION OF COMPONENTS AMONG
TYPE I and TYPE II (dissolved and adsorbed) species

Component	Percent		Species #	Species
H+1				
	9.7	PERCENT BOUND IN SPECIES	#5001401	NaHCO3 AQ
	119.2	PERCENT BOUND IN SPECIES	#3301400	HCO3 -
Na+1				
	70.8	PERCENT BOUND IN SPECIES	# 500	Na+1
	29.1	PERCENT BOUND IN SPECIES	#5001400	NaCO3 -
CO3-2				
	38.4	PERCENT BOUND IN SPECIES	# 140	CO3-2
	58.4	PERCENT BOUND IN SPECIES	#5001400	NaCO3 -
	2.9	PERCENT BOUND IN SPECIES	#3301400	HCO3 -
NO3-1				
	100.0	PERCENT BOUND IN SPECIES	# 492	NO3-1
Cl-1				
	100.0	PERCENT BOUND IN SPECIES	# 180	Cl-1
H2O				
	100.0	PERCENT BOUND IN SPECIES	#3300020	OH-
Ca+2				
	12.3	PERCENT BOUND IN SPECIES	# 150	Ca+2
	87.4	PERCENT BOUND IN SPECIES	#1501401	CaCO3 AQ
Mg+2				
	17.1	PERCENT BOUND IN SPECIES	# 460	Mg+2
	1.1	PERCENT BOUND IN SPECIES	#4603300	MgOH +
	81.5	PERCENT BOUND IN SPECIES	#4601400	MgCO3 AQ

----------- EQUILIBRATED MASS DISTRIBUTION -----------

IDX	NAME	DISSOLVED		SORBED		PRECIPITATED	
		MOL/KG	PERCENT	MOL/KG	PERCENT	MOL/KG	PERCENT
330	H+1	5.227E-03	100.0	0.000E-01	0.0	0.000E-01	0.0
500	Na+1	4.340E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
140	CO3-2	2.163E-01	99.7	0.000E-01	0.0	6.586E-04	0.3
492	NO3-1	5.228E-03	100.0	0.000E-01	0.0	0.000E-01	0.0
180	Cl-1	5.000E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
2	H2O	1.508E-03	100.0	0.000E-01	0.0	0.000E-01	0.0
150	Ca+2	1.607E-06	0.6	0.000E-01	0.0	2.484E-04	99.4
460	Mg+2	9.826E-06	2.3	0.000E-01	0.0	4.102E-04	97.7

Charge Balance: SPECIATED

Sum of CATIONS = 3.071E-01 Sum of ANIONS 3.062E-01

PERCENT DIFFERENCE = 1.400E-01 (ANIONS - CATIONS)/(ANIONS + CATIONS)

EQUILIBRIUM IONIC STRENGTH (m) = 3.898E-01

EQUILIBRIUM pH = 11.000

DATE ID NUMBER: 940908
TIME ID NUMBER: 8311792

Saturation indices and stoichiometry of all minerals

ID #	NAME	Sat. Index	Stoichiometry in [brackets]					
5015000	ARAGONITE	-0.631	[1.000]	150	[1.000]	140		
5046000	ARTINITE	-1.967	[-2.000]	330	[2.000]	460	[1.000]	140
			[5.000]	2				
2046000	BRUCITE	-1.108	[1.000]	460	[2.000]	2	[-2.000]	330
5015001	CALCITE	-0.495	[1.000]	150	[1.000]	140		
5015002	DOLOMITE	0.000	[1.000]	150	[1.000]	460	[2.000]	140
4150000	HALITE	-5.696	[1.000]	500	[1.000]	180		
5015003	HUNTITE	-3.077	[3.000]	460	[1.000]	150	[4.000]	140
5046001	HYDRMAGNESIT	-7.681	[5.000]	460	[4.000]	140	[-2.000]	330
			[6.000]	2				
5046002	MAGNESITE	0.000	[1.000]	460	[1.000]	140		
3050000	NATRON	-1.775	[2.000]	500	[1.000]	140	[10.000]	2
5046003	NESQUEHONITE	-2.424	[1.000]	460	[1.000]	140	[3.000]	2
5050001	THERMONATR	-3.121	[2.000]	500	[1.000]	140	[1.000]	2
2015000	LIME	-17.990	[-2.000]	330	[1.000]	150	[1.000]	2
2015001	PORTLANDITE	-7.911	[-2.000]	330	[1.000]	150	[2.000]	2
2046001	PERICLASE	-5.795	[-2.000]	330	[1.000]	460	[1.000]	2

Run 4 - 10 g/l Na; 10 mg/l Ca; 10 mg/l Mg; sample 2; pH 10,0
add HNO3; allow ppt

Type I - COMPONENTS AS SPECIES IN SOLUTION

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
330	H+1	1.414E-10	1.004E-10	-9.99843	0.70986	0.149
500	Na+1	3.278E-01	2.327E-01	-0.63316	0.70986	0.149
140	CO3-2	6.290E-02	1.597E-02	-1.79665	0.25392	0.595
150	Ca+2	2.605E-07	6.614E-08	-7.17954	0.25392	0.595
180	Cl-1	5.000E-04	3.549E-04	-3.44986	0.70986	0.149
460	Mg+2	2.228E-06	5.656E-07	-6.24746	0.25392	0.595
492	NO3-1	5.124E-02	3.637E-02	-1.43922	0.70986	0.149

Type II - OTHER SPECIES IN SOLUTION OR ADSORBED

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
3301401	H2CO3 AQ	6.965E-06	7.620E-06	-5.11803	1.09404	16.636
3300020	OH-	1.501E-04	1.065E-04	-3.97248	0.70986	-13.816
4603300	MgOH +	1.406E-08	9.979E-09	-8.00091	0.70986	-11.597
4601400	MgCO3 AQ	8.003E-06	8.756E-06	-5.05772	1.09404	2.947
4601401	MgHCO3 +	3.128E-07	2.221E-07	-6.65351	0.70986	11.538
1503300	CaOH +	2.510E-10	1.782E-10	-9.74910	0.70986	-12.414
1501400	CaHCO3 +	3.341E-08	2.371E-08	-7.62499	0.70986	11.498
1501401	CaCO3 AQ	1.404E-06	1.536E-06	-5.81354	1.09404	3.124
5001400	NaCO3 -	1.021E-01	7.245E-02	-1.13998	0.70986	1.439
5001401	NaHCO3 AQ	4.099E-03	4.485E-03	-2.34825	1.09404	10.041
3301400	HCO3 -	4.727E-02	3.355E-02	-1.47427	0.70986	10.470

Type III - SPECIES WITH FIXED ACTIVITY

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
2	H2O	-1.501E-04	-3.824	0.006	0.000

Type IV - FINITE SOLIDS (present at equilibrium)

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
5015002	DOLOMITE	2.483E-04	-3.605	17.020	8.290
5046002	MAGNESITE	1.611E-04	-3.793	8.044	6.169

Type V - UNDERSATURATED SOLIDS (not present at equilibrium)

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
2046000	BRUCITE	1.022E-03	-2.990	-16.729	25.840
5015001	CALCITE	3.200E-01	-0.495	8.481	2.585
5015000	ARAGONITE	2.339E-01	-0.631	8.345	2.615
4150000	HALITE	2.151E-06	-5.667	-1.584	-0.918
5015003	HUNTITE	8.367E-04	-3.077	30.031	25.760
5046001	HYDRMAGNESIT	2.712E-10	-9.567	8.894	52.210
5046000	ARTINITE	1.405E-04	-3.852	-9.530	28.742
3050000	NATRON	1.424E-02	-1.847	1.272	-15.745
5046003	NESQUEHONITE	3.752E-03	-2.426	5.635	5.789
5050001	THERMONATR	6.505E-04	-3.187	-0.118	2.802
2015000	LIME	1.343E-20	-19.872	-32.684	46.265
2015001	PORTLANDITE	1.608E-10	-9.794	-22.600	30.690
2046001	PERICLASE	2.101E-08	-7.678	-21.421	36.135

Type VI - EXCLUDED SPECIES (not included in mole balance)

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
3301403	CO2 (g)	2.348E-04	-3.629	18.159	-0.530

PERCENTAGE DISTRIBUTION OF COMPONENTS AMONG
TYPE I and TYPE II (dissolved and adsorbed) species

Component	Percent		Species #	Species
H+1				
	8.0	PERCENT BOUND IN SPECIES	#5001401	NaHCO3 AQ
	92.3	PERCENT BOUND IN SPECIES	#3301400	HCO3 -
Na+1				
	75.5	PERCENT BOUND IN SPECIES	# 500	Na+1
	23.5	PERCENT BOUND IN SPECIES	#5001400	NaCO3 -
CO3-2				
	29.1	PERCENT BOUND IN SPECIES	# 140	CO3-2
	47.2	PERCENT BOUND IN SPECIES	#5001400	NaCO3 -
	1.9	PERCENT BOUND IN SPECIES	#5001401	NaHCO3 AQ
	21.8	PERCENT BOUND IN SPECIES	#3301400	HCO3 -
NO3-1				
	100.0	PERCENT BOUND IN SPECIES	# 492	NO3-1
Cl-1				
	100.0	PERCENT BOUND IN SPECIES	# 180	Cl-1
H2O				
	100.0	PERCENT BOUND IN SPECIES	#3300020	OH-
Ca+2				
	15.3	PERCENT BOUND IN SPECIES	# 150	Ca+2
	2.0	PERCENT BOUND IN SPECIES	#1501400	CaHCO3 +
	82.7	PERCENT BOUND IN SPECIES	#1501401	CaCO3 AQ
Mg+2				
	21.1	PERCENT BOUND IN SPECIES	# 460	Mg+2
	75.8	PERCENT BOUND IN SPECIES	#4601400	MgCO3 AQ
	3.0	PERCENT BOUND IN SPECIES	#4601401	MgHCO3 +

----------- EQUILIBRATED MASS DISTRIBUTION -----------

IDX	NAME	DISSOLVED		SORBED		PRECIPITATED	
		MOL/KG	PERCENT	MOL/KG	PERCENT	MOL/KG	PERCENT
330	H+1	5.123E-02	100.0	0.000E-01	0.0	0.000E-01	0.0
500	Na+1	4.340E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
140	CO3-2	2.163E-01	99.7	0.000E-01	0.0	6.577E-04	0.3
492	NO3-1	5.124E-02	100.0	0.000E-01	0.0	0.000E-01	0.0
180	Cl-1	5.000E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
2	H2O	1.501E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
150	Ca+2	1.698E-06	0.7	0.000E-01	0.0	2.483E-04	99.3
460	Mg+2	1.056E-05	2.5	0.000E-01	0.0	4.094E-04	97.5

Charge Balance: SPECIATED

Sum of CATIONS = 3.278E-01 Sum of ANIONS 3.270E-01

PERCENT DIFFERENCE = 1.271E-01 (ANIONS - CATIONS)/(ANIONS + CATIONS)

EQUILIBRIUM IONIC STRENGTH (m) = 3.903E-01

EQUILIBRIUM pH = 9.998

DATE ID NUMBER: 940908
TIME ID NUMBER: 8295135

Saturation indices and stoichiometry of all minerals

ID #	NAME	Sat. Index	Stoichiometry in [brackets]		
5015000	ARAGONITE	-0.631	[1.000] 150	[1.000] 140	
5046000	ARTINITE	-3.852	[-2.000] 330	[2.000] 460	[1.000] 140
			[5.000] 2		
2046000	BRUCITE	-2.990	[1.000] 460	[2.000] 2	[-2.000] 330
5015001	CALCITE	-0.495	[1.000] 150	[1.000] 140	
5015002	DOLOMITE	0.000	[1.000] 150	[1.000] 460	[2.000] 140
4150000	HALITE	-5.667	[1.000] 500	[1.000] 180	
5015003	HUNTITE	-3.077	[3.000] 460	[1.000] 150	[4.000] 140
5046001	HYDRMAGNESIT	-9.567	[5.000] 460	[4.000] 140	[-2.000] 330
			[6.000] 2		
5046002	MAGNESITE	0.000	[1.000] 460	[1.000] 140	
3050000	NATRON	-1.847	[2.000] 500	[1.000] 140	[10.000] 2
5046003	NESQUEHONITE	-2.426	[1.000] 460	[1.000] 140	[3.000] 2
5050001	THERMONATR	-3.187	[2.000] 500	[1.000] 140	[1.000] 2
2015000	LIME	-19.872	[-2.000] 330	[1.000] 150	[1.000] 2
2015001	PORTLANDITE	-9.794	[-2.000] 330	[1.000] 150	[2.000] 2
2046001	PERICLASE	-7.678	[-2.000] 330	[1.000] 460	[1.000] 2

Run 4 - 10 g/l Na; 10 mg/l Ca; 10 mg/l Mg; sample 3; pH 9,0
add HNO3; allow ppt

Type I - COMPONENTS AS SPECIES IN SOLUTION

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
330	H+1	1.429E-09	1.013E-09	-8.99429	0.70929	0.149
500	Na+1	3.829E-01	2.716E-01	-0.56606	0.70929	0.149
140	CO3-2	1.926E-02	4.875E-03	-2.31200	0.25311	0.597
150	Ca+2	8.561E-07	2.167E-07	-6.66419	0.25311	0.597
180	Cl-1	5.000E-04	3.547E-04	-3.45018	0.70929	0.149
460	Mg+2	7.321E-06	1.853E-06	-5.73211	0.25311	0.597
492	NO3-1	1.609E-01	1.141E-01	-0.94260	0.70929	0.149

Type II - OTHER SPECIES IN SOLUTION OR ADSORBED

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
3301401	H2CO3 AQ	2.161E-04	2.371E-04	-3.62509	1.09693	16.635
3300020	OH-	1.482E-05	1.051E-05	-4.97826	0.70929	-13.816
4603300	MgOH +	4.548E-09	3.226E-09	-8.49135	0.70929	-11.597
4601400	MgCO3 AQ	7.982E-06	8.756E-06	-5.05772	1.09693	2.946
4601401	MgHCO3 +	3.161E-06	2.242E-06	-5.64936	0.70929	11.538
1503300	CaOH +	8.121E-11	5.761E-11	-10.23954	0.70929	-12.413
1501400	CaHCO3 +	3.375E-07	2.394E-07	-6.62085	0.70929	11.499
1501401	CaCO3 AQ	1.400E-06	1.536E-06	-5.81354	1.09693	3.122
5001400	NaCO3 -	3.639E-02	2.581E-02	-1.58823	0.70929	1.439
5001401	NaHCO3 AQ	1.471E-02	1.613E-02	-1.79236	1.09693	10.040
3301400	HCO3 -	1.458E-01	1.034E-01	-0.98548	0.70929	10.470

Type III - SPECIES WITH FIXED ACTIVITY

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
2	H2O	-1.483E-05	-4.829	0.007	0.000

Type IV - FINITE SOLIDS (present at equilibrium)

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
5015002	DOLOMITE	2.474E-04	-3.607	17.020	8.290
5046002	MAGNESITE	1.541E-04	-3.812	8.044	6.169

Type V - UNDERSATURATED SOLIDS (not present at equilibrium)

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
2046000	BRUCITE	3.260E-05	-4.487	-16.729	25.840
5015001	CALCITE	3.200E-01	-0.495	8.481	2.585
5015000	ARAGONITE	2.339E-01	-0.631	8.345	2.615
4150000	HALITE	2.509E-06	-5.600	-1.584	-0.918
5015003	HUNTITE	8.367E-04	-3.077	30.031	25.760
5046001	HYDRMAGNESIT	8.520E-12	-11.070	8.894	52.210
5046000	ARTINITE	4.431E-06	-5.353	-9.530	28.742
3050000	NATRON	5.699E-03	-2.244	1.272	-15.745
5046003	NESQUEHONITE	3.710E-03	-2.431	5.635	5.789
5050001	THERMONATR	2.695E-04	-3.570	-0.118	2.802
2015000	LIME	4.300E-22	-21.367	-32.684	46.265
2015001	PORTLANDITE	5.130E-12	-11.290	-22.600	30.690
2046001	PERICLASE	6.726E-10	-9.172	-21.421	36.135

Type VI - EXCLUDED SPECIES (not included in mole balance)

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
3301403	CO2 (g)	7.334E-03	-2.135	18.159	-0.530

PERCENTAGE DISTRIBUTION OF COMPONENTS AMONG
TYPE I and TYPE II (dissolved and adsorbed) species

H+1			
	9.1	PERCENT BOUND IN SPECIES #5001401	NaHCO3 AQ
	90.6	PERCENT BOUND IN SPECIES #3301400	HCO3 -
Na+1			
	88.2	PERCENT BOUND IN SPECIES # 500	Na+1
	8.4	PERCENT BOUND IN SPECIES #5001400	NaCO3 -
	3.4	PERCENT BOUND IN SPECIES #5001401	NaHCO3 AQ
CO3-2			
	8.9	PERCENT BOUND IN SPECIES # 140	CO3-2
	16.8	PERCENT BOUND IN SPECIES #5001400	NaCO3 -
	6.8	PERCENT BOUND IN SPECIES #5001401	NaHCO3 AQ
	67.4	PERCENT BOUND IN SPECIES #3301400	HCO3 -
NO3-1			
	100.0	PERCENT BOUND IN SPECIES # 492	NO3-1
Cl-1			
	100.0	PERCENT BOUND IN SPECIES # 180	Cl-1
H2O			
	100.0	PERCENT BOUND IN SPECIES #3300020	OH-
Ca+2			
	33.0	PERCENT BOUND IN SPECIES # 150	Ca+2
	13.0	PERCENT BOUND IN SPECIES #1501400	CaHCO3 +
	54.0	PERCENT BOUND IN SPECIES #1501401	CaCO3 AQ
Mg+2			
	39.6	PERCENT BOUND IN SPECIES # 460	Mg+2
	43.2	PERCENT BOUND IN SPECIES #4601400	MgCO3 AQ
	17.1	PERCENT BOUND IN SPECIES #4601401	MgHCO3 +

----------- EQUILIBRATED MASS DISTRIBUTION -----------

IDX	NAME	DISSOLVED MOL/KG	DISSOLVED PERCENT	SORBED MOL/KG	SORBED PERCENT	PRECIPITATED MOL/KG	PRECIPITATED PERCENT
330	H+1	1.609E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
500	Na+1	4.340E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
140	CO3-2	2.164E-01	99.7	0.000E-01	0.0	6.489E-04	0.3
492	NO3-1	1.609E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
180	Cl-1	5.000E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
2	H2O	1.483E-05	100.0	0.000E-01	0.0	0.000E-01	0.0
150	Ca+2	2.594E-06	1.0	0.000E-01	0.0	2.474E-04	99.0
460	Mg+2	1.847E-05	4.4	0.000E-01	0.0	4.015E-04	95.6

Charge Balance: SPECIATED

Sum of CATIONS = 3.829E-01 Sum of ANIONS 3.821E-01

PERCENT DIFFERENCE = 1.091E-01 (ANIONS - CATIONS)/(ANIONS + CATIONS)

EQUILIBRIUM IONIC STRENGTH (m) = 4.018E-01

EQUILIBRIUM pH = 8.994

DATE ID NUMBER: 940908
TIME ID NUMBER: 8280348

Saturation indices and stoichiometry of all minerals

ID #	NAME	Sat. Index	Stoichiometry in [brackets]		
5015000	ARAGONITE	-0.631	[1.000] 150	[1.000] 140	
5046000	ARTINITE	-5.353	[-2.000] 330	[2.000] 460	[1.000] 140
			[5.000] 2		
2046000	BRUCITE	-4.487	[1.000] 460	[2.000] 2	[-2.000] 330
5015001	CALCITE	-0.495	[1.000] 150	[1.000] 140	
5015002	DOLOMITE	0.000	[1.000] 150	[1.000] 460	[2.000] 140
4150000	HALITE	-5.600	[1.000] 500	[1.000] 180	
5015003	HUNTITE	-3.077	[3.000] 460	[1.000] 150	[4.000] 140
5046001	HYDRMAGNESIT	-11.070	[5.000] 460	[4.000] 140	[-2.000] 330
			[6.000] 2		
5046002	MAGNESITE	0.000	[1.000] 460	[1.000] 140	
3050000	NATRON	-2.244	[2.000] 500	[1.000] 140	[10.000] 2
5046003	NESQUEHONITE	-2.431	[1.000] 460	[1.000] 140	[3.000] 2
5050001	THERMONATR	-3.570	[2.000] 500	[1.000] 140	[1.000] 2
2015000	LIME	-21.367	[-2.000] 330	[1.000] 150	[1.000] 2
2015001	PORTLANDITE	-11.290	[-2.000] 330	[1.000] 150	[2.000] 2
2046001	PERICLASE	-9.172	[-2.000] 330	[1.000] 460	[1.000] 2

Run 4 - 10 g/l Na; 10 mg/l Ca; 10 mg/l Mg; sample 4; pH 8,2
add HNO3; allow ppt

Type I - COMPONENTS AS SPECIES IN SOLUTION

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
330	H+1	9.345E-09	6.625E-09	-8.17881	0.70892	0.149
500	Na+1	4.069E-01	2.885E-01	-0.53989	0.70892	0.149
140	CO3-2	3.720E-03	9.395E-04	-3.02708	0.25257	0.598
150	Ca+2	4.451E-06	1.124E-06	-5.94912	0.25257	0.598
180	Cl-1	5.000E-04	3.545E-04	-3.45041	0.70892	0.149
460	Mg+2	3.807E-05	9.615E-06	-5.01703	0.25257	0.598
492	NO3-1	2.070E-01	1.468E-01	-0.83341	0.70892	0.149

Type II - OTHER SPECIES IN SOLUTION OR ADSORBED

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
3301401	H2CO3 AQ	1.777E-03	1.953E-03	-2.70921	1.09910	16.634
3300020	OH-	2.264E-06	1.605E-06	-5.79443	0.70892	-13.816
4603300	MgOH +	3.605E-09	2.556E-09	-8.59244	0.70892	-11.597
4601400	MgCO3 AQ	7.966E-06	8.756E-06	-5.05772	1.09910	2.945
4601401	MgHCO3 +	2.068E-05	1.466E-05	-4.83388	0.70892	11.538
1503300	CaOH +	6.438E-11	4.564E-11	-10.34063	0.70892	-12.413
1501400	CaHCO3 +	2.208E-06	1.565E-06	-5.80537	0.70892	11.499
1501401	CaCO3 AQ	1.398E-06	1.536E-06	-5.81354	1.09910	3.122
5001400	NaCO3 -	7.452E-03	5.283E-03	-2.27714	0.70892	1.439
5001401	NaHCO3 AQ	1.964E-02	2.159E-02	-1.66579	1.09910	10.039
3301400	HCO3 -	1.838E-01	1.303E-01	-0.88508	0.70892	10.470

Type III - SPECIES WITH FIXED ACTIVITY

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
2	H2O	-2.268E-06	-5.644	0.008	0.000

Type IV - FINITE SOLIDS (present at equilibrium)

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
5015002	DOLOMITE	2.419E-04	-3.616	17.020	8.290
5046002	MAGNESITE	1.113E-04	-3.953	8.044	6.169

Type V - UNDERSATURATED SOLIDS (not present at equilibrium)

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
2046000	BRUCITE	3.945E-06	-5.404	-16.729	25.840
5015001	CALCITE	3.200E-01	-0.495	8.481	2.585
5015000	ARAGONITE	2.339E-01	-0.631	8.345	2.615
4150000	HALITE	2.663E-06	-5.575	-1.584	-0.918
5015003	HUNTITE	8.367E-04	-3.077	30.031	25.760
5046001	HYDRMAGNESIT	1.024E-12	-11.990	8.894	52.210
5046000	ARTINITE	5.336E-07	-6.273	-9.530	28.742
3050000	NATRON	1.219E-03	-2.914	1.272	-15.745
5046003	NESQUEHONITE	3.692E-03	-2.433	5.635	5.789
5050001	THERMONATR	5.849E-05	-4.233	-0.118	2.802
2015000	LIME	5.211E-23	-22.283	-32.684	46.265
2015001	PORTLANDITE	6.206E-13	-12.207	-22.600	30.690
2046001	PERICLASE	8.151E-11	-10.089	-21.421	36.135

Type VI - EXCLUDED SPECIES (not included in mole balance)

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
3301403	CO2 (g)	6.053E-02	-1.218	18.159	-0.530

PERCENTAGE DISTRIBUTION OF COMPONENTS AMONG
TYPE I and TYPE II (dissolved and adsorbed) species

H+1			
	1.7	PERCENT BOUND IN SPECIES #3301401	H2CO3 AQ
	9.5	PERCENT BOUND IN SPECIES #5001401	NaHCO3 AQ
	88.8	PERCENT BOUND IN SPECIES #3301400	HCO3 -
Na+1			
	93.8	PERCENT BOUND IN SPECIES # 500	Na+1
	1.7	PERCENT BOUND IN SPECIES #5001400	NaCO3 -
	4.5	PERCENT BOUND IN SPECIES #5001401	NaHCO3 AQ
CO3-2			
	1.7	PERCENT BOUND IN SPECIES # 140	CO3-2
	3.4	PERCENT BOUND IN SPECIES #5001400	NaCO3 -
	9.1	PERCENT BOUND IN SPECIES #5001401	NaHCO3 AQ
	84.9	PERCENT BOUND IN SPECIES #3301400	HCO3 -
NO3-1			
	100.0	PERCENT BOUND IN SPECIES # 492	NO3-1
Cl-1			
	100.0	PERCENT BOUND IN SPECIES # 180	Cl-1
H2O			
	99.8	PERCENT BOUND IN SPECIES #3300020	OH-
Ca+2			
	55.2	PERCENT BOUND IN SPECIES # 150	Ca+2
	27.4	PERCENT BOUND IN SPECIES #1501400	CaHCO3 +
	17.3	PERCENT BOUND IN SPECIES #1501401	CaCO3 AQ
Mg+2			
	57.1	PERCENT BOUND IN SPECIES # 460	Mg+2
	11.9	PERCENT BOUND IN SPECIES #4601400	MgCO3 AQ
	31.0	PERCENT BOUND IN SPECIES #4601401	MgHCO3 +

----------- EQUILIBRATED MASS DISTRIBUTION -----------

IDX	NAME	DISSOLVED MOL/KG	DISSOLVED PERCENT	SORBED MOL/KG	SORBED PERCENT	PRECIPITATED MOL/KG	PRECIPITATED PERCENT
330	H+1	2.070E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
500	Na+1	4.340E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
140	CO3-2	2.164E-01	99.7	0.000E-01	0.0	5.952E-04	0.3
492	NO3-1	2.070E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
180	Cl-1	5.000E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
2	H2O	2.268E-06	100.0	0.000E-01	0.0	0.000E-01	0.0
150	Ca+2	8.057E-06	3.2	0.000E-01	0.0	2.419E-04	96.8
460	Mg+2	6.672E-05	15.9	0.000E-01	0.0	3.533E-04	84.1

Charge Balance: SPECIATED

Sum of CATIONS = 4.070E-01 Sum of ANIONS 4.062E-01

PERCENT DIFFERENCE = 1.028E-01 (ANIONS - CATIONS)/(ANIONS + CATIONS)

EQUILIBRIUM IONIC STRENGTH (m) = 4.104E-01

EQUILIBRIUM pH = 8.179

DATE ID NUMBER: 940908
TIME ID NUMBER: 8263087

Saturation indices and stoichiometry of all minerals

ID #	NAME	Sat. Index	Stoichiometry in [brackets]					
5015000	ARAGONITE	-0.631	[1.000]	150	[1.000]	140		
5046000	ARTINITE	-6.273	[-2.000]	330	[2.000]	460	[1.000]	140
			[5.000]	2				
2046000	BRUCITE	-5.404	[1.000]	460	[2.000]	2	[-2.000]	330
5015001	CALCITE	-0.495	[1.000]	150	[1.000]	140		
5015002	DOLOMITE	0.000	[1.000]	150	[1.000]	460	[2.000]	140
4150000	HALITE	-5.575	[1.000]	500	[1.000]	180		
5015003	HUNTITE	-3.077	[3.000]	460	[1.000]	150	[4.000]	140
5046001	HYDRMAGNESIT	-11.990	[5.000]	460	[4.000]	140	[-2.000]	330
			[6.000]	2				
5046002	MAGNESITE	0.000	[1.000]	460	[1.000]	140		
3050000	NATRON	-2.914	[2.000]	500	[1.000]	140	[10.000]	2
5046003	NESQUEHONITE	-2.433	[1.000]	460	[1.000]	140	[3.000]	2
5050001	THERMONATR	-4.233	[2.000]	500	[1.000]	140	[1.000]	2
2015000	LIME	-22.283	[-2.000]	330	[1.000]	150	[1.000]	2
2015001	PORTLANDITE	-12.207	[-2.000]	330	[1.000]	150	[2.000]	2
2046001	PERICLASE	-10.089	[-2.000]	330	[1.000]	460	[1.000]	2

Run 4 - 10 g/l Na; 10 mg/l Ca and Mg; sample 5; pH 7,2
add HNO3; allow ppt

Type I - COMPONENTS AS SPECIES IN SOLUTION

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
330	H+1	9.327E-08	6.610E-08	-7.17978	0.70874	0.150
500	Na+1	4.138E-01	2.933E-01	-0.53267	0.70874	0.150
140	CO3-2	3.631E-04	9.162E-05	-4.03802	0.25231	0.598
150	Ca+2	9.022E-05	2.276E-05	-4.64274	0.25231	0.598
180	Cl-1	5.000E-04	3.544E-04	-3.45055	0.70874	0.150
460	Mg+2	1.979E-04	4.994E-05	-4.30154	0.25231	0.598
492	NO3-1	2.329E-01	1.651E-01	-0.78235	0.70874	0.150

Type II - OTHER SPECIES IN SOLUTION OR ADSORBED

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
3301401	H2CO3 AQ	1.724E-02	1.896E-02	-1.72208	1.10022	16.634
3300020	OH-	2.268E-07	1.607E-07	-6.79386	0.70874	-13.816
4603300	MgOH +	1.876E-09	1.329E-09	-8.87637	0.70874	-11.597
4601400	MgCO3 AQ	4.031E-06	4.434E-06	-5.35316	1.10022	2.945
4601401	MgHCO3 +	1.045E-04	7.408E-05	-4.13029	0.70874	11.539
1503300	CaOH +	1.306E-10	9.254E-11	-10.03368	0.70874	-12.413
1501400	CaHCO3 +	4.351E-05	3.084E-05	-4.51089	0.70874	11.499
1501401	CaCO3 AQ	2.757E-06	3.033E-06	-5.51810	1.10022	3.121
5001400	NaCO3 -	7.390E-04	5.238E-04	-3.28086	0.70874	1.439
5001401	NaHCO3 AQ	1.941E-02	2.136E-02	-1.67047	1.10022	10.039
3301400	HCO3 -	1.789E-01	1.268E-01	-0.89698	0.70874	10.470

Type III - SPECIES WITH FIXED ACTIVITY

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
2	H2O	-2.288E-07	-6.641	0.008	0.000

Type IV - FINITE SOLIDS (present at equilibrium)

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
5015002	DOLOMITE	1.135E-04	-3.945	17.020	8.290

Type V - UNDERSATURATED SOLIDS (not present at equilibrium)

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
5046000	ARTINITE	1.404E-08	-7.853	-9.530	28.742
2046000	BRUCITE	2.054E-07	-6.687	-16.729	25.840
5015001	CALCITE	6.319E-01	-0.199	8.481	2.585
5015000	ARAGONITE	4.618E-01	-0.336	8.345	2.615
4150000	HALITE	2.707E-06	-5.567	-1.584	-0.918
5015003	HUNTITE	2.146E-04	-3.668	30.031	25.760
5046001	HYDRMAGNESIT	3.497E-15	-14.456	8.894	52.210
5046002	MAGNESITE	5.065E-01	-0.295	8.044	6.169
3050000	NATRON	1.218E-04	-3.914	1.272	-15.745
5046003	NESQUEHONITE	1.865E-03	-2.729	5.635	5.789
5050001	THERMONATR	5.891E-06	-5.230	-0.118	2.802
2015000	LIME	1.059E-23	-22.975	-32.684	46.265
2015001	PORTLANDITE	1.260E-13	-12.900	-22.600	30.690
2046001	PERICLASE	4.248E-12	-11.372	-21.421	36.135

Type VI - EXCLUDED SPECIES (not included in mole balance)

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
3301403	CO2 (g)	5.881E-01	-0.231	18.159	-0.530

PERCENTAGE DISTRIBUTION OF COMPONENTS AMONG
TYPE I and TYPE II (dissolved and adsorbed) species

H+1

14.8	PERCENT BOUND IN SPECIES #3301401	H2CO3 AQ
8.3	PERCENT BOUND IN SPECIES #5001401	NaHCO3 AQ
76.8	PERCENT BOUND IN SPECIES #3301400	HCO3 -

Na+1

95.4	PERCENT BOUND IN SPECIES # 500	Na+1
4.5	PERCENT BOUND IN SPECIES #5001401	NaHCO3 AQ

CO3-2

8.0	PERCENT BOUND IN SPECIES #3301401	H2CO3 AQ
9.0	PERCENT BOUND IN SPECIES #5001401	NaHCO3 AQ
82.5	PERCENT BOUND IN SPECIES #3301400	HCO3 -

Ca+2

66.1	PERCENT BOUND IN SPECIES # 150	Ca+2
31.9	PERCENT BOUND IN SPECIES #1501400	CaHCO3 +
2.0	PERCENT BOUND IN SPECIES #1501401	CaCO3 AQ

Cl-1

100.0	PERCENT BOUND IN SPECIES # 180	Cl-1

NO3-1

100.0	PERCENT BOUND IN SPECIES # 492	NO3-1

H2O

99.1	PERCENT BOUND IN SPECIES #3300020	OH-

Mg+2

64.6	PERCENT BOUND IN SPECIES # 460	Mg+2
1.3	PERCENT BOUND IN SPECIES #4601400	MgCO3 AQ
34.1	PERCENT BOUND IN SPECIES #4601401	MgHCO3 +

----------- EQUILIBRATED MASS DISTRIBUTION -----------

IDX	NAME	DISSOLVED		SORBED		PRECIPITATED	
		MOL/KG	PERCENT	MOL/KG	PERCENT	MOL/KG	PERCENT
330	H+1	2.329E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
500	Na+1	4.340E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
140	CO3-2	2.168E-01	99.9	0.000E-01	0.0	2.270E-04	0.1
150	Ca+2	1.365E-04	54.6	0.000E-01	0.0	1.135E-04	45.4
180	Cl-1	5.000E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
492	NO3-1	2.329E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
2	H2O	2.288E-07	100.0	0.000E-01	0.0	0.000E-01	0.0
460	Mg+2	3.065E-04	73.0	0.000E-01	0.0	1.135E-04	27.0

Charge Balance: SPECIATED

Sum of CATIONS = 4.146E-01 Sum of ANIONS 4.137E-01

PERCENT DIFFERENCE = 1.014E-01 (ANIONS - CATIONS)/(ANIONS + CATIONS)

EQUILIBRIUM IONIC STRENGTH (m) = 4.148E-01

EQUILIBRIUM pH = 7.180

DATE ID NUMBER: 940908
TIME ID NUMBER: 8220278

Saturation indices and stoichiometry of all minerals

ID #	NAME	Sat. Index	Stoichiometry in [brackets]					
5015000	ARAGONITE	-0.336	[1.000]	150	[1.000]	140		
5046000	ARTINITE	-7.853	[-2.000]	330	[2.000]	460	[1.000]	140
			[5.000]	2				
2046000	BRUCITE	-6.687	[1.000]	460	[2.000]	2	[-2.000]	330
5015001	CALCITE	-0.199	[1.000]	150	[1.000]	140		
5015002	DOLOMITE	0.000	[1.000]	150	[1.000]	460	[2.000]	140
4150000	HALITE	-5.567	[1.000]	500	[1.000]	180		
5015003	HUNTITE	-3.668	[3.000]	460	[1.000]	150	[4.000]	140
5046001	HYDRMAGNESIT	-14.456	[5.000]	460	[4.000]	140	[-2.000]	330
			[6.000]	2				
5046002	MAGNESITE	-0.295	[1.000]	460	[1.000]	140		
3050000	NATRON	-3.914	[2.000]	500	[1.000]	140	[10.000]	2
5046003	NESQUEHONITE	-2.729	[1.000]	460	[1.000]	140	[3.000]	2
5050001	THERMONATR	-5.230	[2.000]	500	[1.000]	140	[1.000]	2
2015000	LIME	-22.975	[-2.000]	330	[1.000]	150	[1.000]	2
2015001	PORTLANDITE	-12.900	[-2.000]	330	[1.000]	150	[2.000]	2
2046001	PERICLASE	-11.372	[-2.000]	330	[1.000]	460	[1.000]	2

Run 5 - 10 g/l Na; 10 mg/l Ca and Mg; sample 1; pH 11
add HNO3; allow ppt

Type I - COMPONENTS AS SPECIES IN SOLUTION

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
330	H+1	1.409E-11	1.000E-11	-10.99992	0.70983	0.149
500	Na+1	3.069E-01	2.179E-01	-0.66183	0.70983	0.149
150	Ca+2	7.527E-08	1.911E-08	-7.71875	0.25388	0.595
180	Cl-1	5.000E-04	3.549E-04	-3.44987	0.70983	0.149
460	Mg+2	1.682E-06	4.270E-07	-6.36962	0.25388	0.595
969	EDTA-4	3.175E-07	1.319E-09	-8.87976	0.00415	2.382
140	CO3-2	8.334E-02	2.116E-02	-1.67450	0.25388	0.595
492	NO3-1	5.239E-03	3.719E-03	-2.42960	0.70983	0.149

Type II - OTHER SPECIES IN SOLUTION OR ADSORBED

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
5009690	Na EDTA	1.986E-06	9.087E-08	-7.04158	0.04575	3.840
3300020	OH-	1.508E-03	1.071E-03	-2.97030	0.70983	-13.816
4603300	MgOH +	1.066E-07	7.570E-08	-7.12090	0.70983	-11.597
4601400	MgCO3 AQ	8.002E-06	8.756E-06	-5.05772	1.09418	2.947
4601401	MgHCO3 +	3.118E-08	2.213E-08	-7.65500	0.70983	11.538
1503300	CaOH +	7.290E-10	5.174E-10	-9.28614	0.70983	-12.414
1501400	CaHCO3 +	1.274E-09	9.046E-10	-9.04353	0.70983	11.498
1501401	CaCO3 AQ	5.374E-07	5.880E-07	-6.23059	1.09418	3.124
5001400	NaCO3 -	1.266E-01	8.985E-02	-1.04649	0.70983	1.439
5001401	NaHCO3 AQ	5.066E-04	5.543E-04	-3.25625	1.09418	10.041
3301400	HCO3 -	6.241E-03	4.430E-03	-2.35361	0.70983	10.470
3301401	H2CO3 AQ	9.164E-08	1.003E-07	-6.99885	1.09418	16.636
3309691	EDTAH	2.630E-09	1.203E-10	-9.91968	0.04575	11.300
3309692	EDTAH2	8.429E-15	2.140E-15	-14.66960	0.25388	16.805
3309693	EDTAH3	1.347E-23	9.560E-24	-23.01953	0.70983	19.009
3309694	EDTAH4	1.027E-32	1.123E-32	-31.94945	1.09418	20.891
3309695	EDTA H5	5.413E-41	3.843E-41	-40.41538	0.70983	23.613
1509690	Ca EDTA	2.494E-04	6.331E-05	-4.19851	0.25388	12.995
1509691	CaHEDTA	3.552E-12	2.521E-12	-11.59843	0.70983	16.149
4609690	Mg EDTA	8.831E-05	2.242E-05	-4.64938	0.25388	11.195
4609691	MgHEDTA	9.990E-12	7.091E-12	-11.14930	0.70983	15.249

Type III - SPECIES WITH FIXED ACTIVITY

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
2	H2O	-1.509E-03	-2.821	0.005	0.000

Type IV - FINITE SOLIDS (present at equilibrium)

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
5046002	MAGNESITE	3.225E-04	-3.491	8.044	6.169

Type V - UNDERSATURATED SOLIDS (not present at equilibrium)

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
5046000	ARTINITE	1.076E-02	-1.968	-9.530	28.742
2046000	BRUCITE	7.793E-02	-1.108	-16.729	25.840
5015001	CALCITE	1.225E-01	-0.912	8.481	2.585
5015002	DOLOMITE	3.828E-01	-0.417	17.020	8.290
4150000	HALITE	2.014E-06	-5.696	-1.584	-0.918
5015003	HUNTITE	3.203E-04	-3.494	30.031	25.760
5046001	HYDRMAGNESIT	2.080E-08	-7.682	8.894	52.210
5015000	ARAGONITE	8.953E-02	-1.048	8.345	2.615
3050000	NATRON	1.679E-02	-1.775	1.272	-15.745
5046003	NESQUEHONITE	3.770E-03	-2.424	5.635	5.789
5050001	THERMONATR	7.565E-04	-3.121	-0.118	2.802
2015000	LIME	3.913E-19	-18.407	-32.684	46.265
2015001	PORTLANDITE	4.693E-09	-8.329	-22.600	30.690
2046001	PERICLASE	1.599E-06	-5.796	-21.421	36.135

Type VI - EXCLUDED SPECIES (not included in mole balance)

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
3301403	CO2 (g)	3.085E-06	-5.511	18.159	-0.530

PERCENTAGE DISTRIBUTION OF COMPONENTS AMONG
TYPE I and TYPE II (dissolved and adsorbed) species

H+1			
	9.7	PERCENT BOUND IN SPECIES #5001401	NaHCO3 AQ
	119.1	PERCENT BOUND IN SPECIES #3301400	HCO3 -
Na+1			
	70.7	PERCENT BOUND IN SPECIES # 500	Na+1
	29.2	PERCENT BOUND IN SPECIES #5001400	NaCO3 -
Ca+2			
	99.8	PERCENT BOUND IN SPECIES #1509690	Ca EDTA
Cl-1			
	100.0	PERCENT BOUND IN SPECIES # 180	Cl-1
Mg+2			
	1.7	PERCENT BOUND IN SPECIES # 460	Mg+2
	8.2	PERCENT BOUND IN SPECIES #4601400	MgCO3 AQ
	90.0	PERCENT BOUND IN SPECIES #4609690	Mg EDTA
EDTA-4			
	73.3	PERCENT BOUND IN SPECIES #1509690	Ca EDTA
	26.0	PERCENT BOUND IN SPECIES #4609690	Mg EDTA
NO3-1			
	100.0	PERCENT BOUND IN SPECIES # 492	NO3-1
H2O			
	100.0	PERCENT BOUND IN SPECIES #3300020	OH-
CO3-2			
	38.5	PERCENT BOUND IN SPECIES # 140	CO3-2
	58.4	PERCENT BOUND IN SPECIES #5001400	NaCO3 -
	2.9	PERCENT BOUND IN SPECIES #3301400	HCO3 -

----------- EQUILIBRATED MASS DISTRIBUTION -----------

IDX	NAME	DISSOLVED		SORBED		PRECIPITATED	
		MOL/KG	PERCENT	MOL/KG	PERCENT	MOL/KG	PERCENT
330	H+1	5.239E-03	100.0	0.000E-01	0.0	0.000E-01	0.0
500	Na+1	4.340E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
150	Ca+2	2.500E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
180	Cl-1	5.000E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
460	Mg+2	9.813E-05	23.3	0.000E-01	0.0	3.225E-04	76.7
969	EDTA-4	3.400E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
492	NO3-1	5.239E-03	100.0	0.000E-01	0.0	0.000E-01	0.0
2	H2O	1.509E-03	100.0	0.000E-01	0.0	0.000E-01	0.0
140	CO3-2	2.167E-01	99.9	0.000E-01	0.0	3.225E-04	0.1

Charge Balance: SPECIATED

Sum of CATIONS = 3.069E-01 Sum of ANIONS 3.074E-01

PERCENT DIFFERENCE = 8.453E-02 (ANIONS - CATIONS)/(ANIONS + CATIONS)

EQUILIBRIUM IONIC STRENGTH (m) = 3.909E-01

EQUILIBRIUM pH = 11.000

DATE ID NUMBER: 940908
TIME ID NUMBER: 8392516

Saturation indices and stoichiometry of all minerals

ID #	NAME	Sat. Index	Stoichiometry in [brackets]		
5015000	ARAGONITE	-1.048	[1.000] 150	[1.000] 140	
5046000	ARTINITE	-1.968	[-2.000] 330	[2.000] 460	[1.000] 140
			[5.000] 2		
2046000	BRUCITE	-1.108	[1.000] 460	[2.000] 2	[-2.000] 330
5015001	CALCITE	-0.912	[1.000] 150	[1.000] 140	
5015002	DOLOMITE	-0.417	[1.000] 150	[1.000] 460	[2.000] 140
4150000	HALITE	-5.696	[1.000] 500	[1.000] 180	
5015003	HUNTITE	-3.494	[3.000] 460	[1.000] 150	[4.000] 140
5046001	HYDRMAGNESIT	-7.682	[5.000] 460	[4.000] 140	[-2.000] 330
			[6.000] 2		
5046002	MAGNESITE	0.000	[1.000] 460	[1.000] 140	
3050000	NATRON	-1.775	[2.000] 500	[1.000] 140	[10.000] 2
5046003	NESQUEHONITE	-2.424	[1.000] 460	[1.000] 140	[3.000] 2
5050001	THERMONATR	-3.121	[2.000] 500	[1.000] 140	[1.000] 2
2015000	LIME	-18.407	[-2.000] 330	[1.000] 150	[1.000] 2
2015001	PORTLANDITE	-8.329	[-2.000] 330	[1.000] 150	[2.000] 2
2046001	PERICLASE	-5.796	[-2.000] 330	[1.000] 460	[1.000] 2

Run 5 - 10 g/l Na; 10 mg/l Ca and Mg; sample 2; pH 10,0
add HNO3; allow ppt

Type I - COMPONENTS AS SPECIES IN SOLUTION

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
330	H+1	1.413E-10	1.003E-10	-9.99862	0.70981	0.149
500	Na+1	3.277E-01	2.326E-01	-0.63338	0.70981	0.149
140	CO3-2	6.303E-02	1.600E-02	-1.79588	0.25384	0.595
150	Ca+2	9.902E-08	2.514E-08	-7.59970	0.25384	0.595
180	Cl-1	5.000E-04	3.549E-04	-3.44989	0.70981	0.149
460	Mg+2	2.224E-06	5.646E-07	-6.24824	0.25384	0.595
969	EDTA-4	2.414E-07	1.002E-09	-8.99892	0.00415	2.382
492	NO3-1	5.130E-02	3.641E-02	-1.43874	0.70981	0.149

Type II - OTHER SPECIES IN SOLUTION OR ADSORBED

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
5009690	Na EDTA	1.612E-06	7.374E-08	-7.13230	0.04574	3.840
3300020	OH-	1.502E-04	1.066E-04	-3.97229	0.70981	-13.816
4603300	MgOH +	1.404E-08	9.965E-09	-8.00150	0.70981	-11.597
4601400	MgCO3 AQ	8.001E-06	8.756E-06	-5.05772	1.09429	2.947
4601401	MgHCO3 +	3.127E-07	2.220E-07	-6.65369	0.70981	11.538
1503300	CaOH +	9.545E-11	6.775E-11	-10.16908	0.70981	-12.414
1501400	CaHCO3 +	1.271E-08	9.025E-09	-8.04456	0.70981	11.499
1501401	CaCO3 AQ	5.345E-07	5.849E-07	-6.23292	1.09429	3.124
5001400	NaCO3 -	1.022E-01	7.254E-02	-1.13943	0.70981	1.439
5001401	NaHCO3 AQ	4.102E-03	4.489E-03	-2.34788	1.09429	10.041
3301400	HCO3 -	4.733E-02	3.360E-02	-1.47369	0.70981	10.470
3301401	H2CO3 AQ	6.970E-06	7.627E-06	-5.11763	1.09429	16.636
3309691	EDTAH	2.005E-08	9.172E-10	-9.03754	0.04574	11.300
3309692	EDTAH2	6.446E-13	1.636E-13	-12.78617	0.25384	16.805
3309693	EDTAH3	1.033E-20	7.332E-21	-20.13479	0.70981	19.009
3309694	EDTAH4	7.897E-29	8.641E-29	-28.06341	1.09429	20.891
3309695	EDTA H5	4.177E-36	2.965E-36	-35.52804	0.70981	23.613
1509690	Ca EDTA	2.494E-04	6.330E-05	-4.19862	0.25384	12.995
1509691	CaHEDTA	3.561E-11	2.528E-11	-10.59724	0.70981	16.149
4609690	Mg EDTA	8.877E-05	2.253E-05	-4.64716	0.25384	11.195
4609691	MgHEDTA	1.007E-10	7.149E-11	-10.14578	0.70981	15.249

Type III - SPECIES WITH FIXED ACTIVITY

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
2	H2O	-1.502E-04	-3.823	0.006	0.000

Type IV - FINITE SOLIDS (present at equilibrium)

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
5046002	MAGNESITE	3.207E-04	-3.494	8.044	6.169

Type V - UNDERSATURATED SOLIDS (not present at equilibrium)

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
5046000	ARTINITE	1.404E-04	-3.853	-9.530	28.742
2046000	BRUCITE	1.021E-03	-2.991	-16.729	25.840
5015001	CALCITE	1.218E-01	-0.914	8.481	2.585
5015002	DOLOMITE	3.807E-01	-0.419	17.020	8.290
4150000	HALITE	2.150E-06	-5.668	-1.584	-0.918
5015003	HUNTITE	3.186E-04	-3.497	30.031	25.760
5046001	HYDRMAGNESIT	2.709E-10	-9.567	8.894	52.210
5015000	ARAGONITE	8.905E-02	-1.050	8.345	2.615
3050000	NATRON	1.425E-02	-1.846	1.272	-15.745
5046003	NESQUEHONITE	3.752E-03	-2.426	5.635	5.789
5050001	THERMONATR	6.510E-04	-3.186	-0.118	2.802
2015000	LIME	5.108E-21	-20.292	-32.684	46.265
2015001	PORTLANDITE	6.117E-11	-10.213	-22.600	30.690
2046001	PERICLASE	2.099E-08	-7.678	-21.421	36.135

Type VI - EXCLUDED SPECIES (not included in mole balance)

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
3301403	CO2 (g)	2.351E-04	-3.629	18.159	-0.530

PERCENTAGE DISTRIBUTION OF COMPONENTS AMONG
TYPE I and TYPE II (dissolved and adsorbed) species

H+1				
	8.0	PERCENT BOUND IN SPECIES #	5001401	NaHCO3 AQ
	92.3	PERCENT BOUND IN SPECIES #	3301400	HCO3 -
Na+1				
	75.5	PERCENT BOUND IN SPECIES #	500	Na+1
	23.5	PERCENT BOUND IN SPECIES #	5001400	NaCO3 -
CO3-2				
	29.1	PERCENT BOUND IN SPECIES #	140	CO3-2
	47.2	PERCENT BOUND IN SPECIES #	5001400	NaCO3 -
	1.9	PERCENT BOUND IN SPECIES #	5001401	NaHCO3 AQ
	21.8	PERCENT BOUND IN SPECIES #	3301400	HCO3 -
Ca+2				
	99.7	PERCENT BOUND IN SPECIES #	1509690	Ca EDTA
Cl-1				
	100.0	PERCENT BOUND IN SPECIES #	180	Cl-1
NO3-1				
	100.0	PERCENT BOUND IN SPECIES #	492	NO3-1
EDTA-4				
	73.3	PERCENT BOUND IN SPECIES #	1509690	Ca EDTA
	26.1	PERCENT BOUND IN SPECIES #	4609690	Mg EDTA
H2O				
	100.0	PERCENT BOUND IN SPECIES #	3300020	OH-
Mg+2				
	2.2	PERCENT BOUND IN SPECIES #	460	Mg+2
	8.1	PERCENT BOUND IN SPECIES #	4601400	MgCO3 AQ
	89.4	PERCENT BOUND IN SPECIES #	4609690	Mg EDTA

----------- EQUILIBRATED MASS DISTRIBUTION -----------

IDX	NAME	DISSOLVED		SORBED		PRECIPITATED	
		MOL/KG	PERCENT	MOL/KG	PERCENT	MOL/KG	PERCENT
330	H+1	5.130E-02	100.0	0.000E-01	0.0	0.000E-01	0.0
500	Na+1	4.340E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
140	CO3-2	2.167E-01	99.9	0.000E-01	0.0	3.207E-04	0.1
150	Ca+2	2.500E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
180	Cl-1	5.000E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
492	NO3-1	5.130E-02	100.0	0.000E-01	0.0	0.000E-01	0.0
969	EDTA-4	3.400E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
2	H2O	1.502E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
460	Mg+2	9.932E-05	23.6	0.000E-01	0.0	3.207E-04	76.4

Charge Balance: SPECIATED

Sum of CATIONS = 3.277E-01 Sum of ANIONS 3.282E-01

PERCENT DIFFERENCE = 7.926E-02 (ANIONS - CATIONS)/(ANIONS + CATIONS)

EQUILIBRIUM IONIC STRENGTH (m) = 3.913E-01

EQUILIBRIUM pH = 9.999

DATE ID NUMBER: 940908
TIME ID NUMBER: 8382101

Saturation indices and stoichiometry of all minerals

ID #	NAME	Sat. Index	Stoichiometry in [brackets]		
5015000	ARAGONITE	-1.050	[1.000] 150	[1.000] 140	
5046000	ARTINITE	-3.853	[-2.000] 330	[2.000] 460	[1.000] 140
			[5.000] 2		
2046000	BRUCITE	-2.991	[1.000] 460	[2.000] 2	[-2.000] 330
5015001	CALCITE	-0.914	[1.000] 150	[1.000] 140	
5015002	DOLOMITE	-0.419	[1.000] 150	[1.000] 460	[2.000] 140
4150000	HALITE	-5.668	[1.000] 500	[1.000] 180	
5015003	HUNTITE	-3.497	[3.000] 460	[1.000] 150	[4.000] 140
5046001	HYDRMAGNESIT	-9.567	[5.000] 460	[4.000] 140	[-2.000] 330
			[6.000] 2		
5046002	MAGNESITE	0.000	[1.000] 460	[1.000] 140	
3050000	NATRON	-1.846	[2.000] 500	[1.000] 140	[10.000] 2
5046003	NESQUEHONITE	-2.426	[1.000] 460	[1.000] 140	[3.000] 2
5050001	THERMONATR	-3.186	[2.000] 500	[1.000] 140	[1.000] 2
2015000	LIME	-20.292	[-2.000] 330	[1.000] 150	[1.000] 2
2015001	PORTLANDITE	-10.213	[-2.000] 330	[1.000] 150	[2.000] 2
2046001	PERICLASE	-7.678	[-2.000] 330	[1.000] 460	[1.000] 2

Run 5 - 10 g/l Na; 10 mg/l Ca and Mg; sample 3; pH 9
add HNO3; allow ppt

Type I - COMPONENTS AS SPECIES IN SOLUTION

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
330	H+1	1.427E-09	1.012E-09	-8.99484	0.70925	0.149
500	Na+1	3.828E-01	2.715E-01	-0.56621	0.70925	0.149
140	CO3-2	1.931E-02	4.887E-03	-2.31092	0.25304	0.597
150	Ca+2	3.195E-07	8.084E-08	-7.09235	0.25304	0.597
180	Cl-1	5.000E-04	3.546E-04	-3.45023	0.70925	0.149
460	Mg+2	7.305E-06	1.848E-06	-5.73319	0.25304	0.597
969	EDTA-4	7.569E-08	3.103E-10	-9.50820	0.00410	2.387
492	NO3-1	1.611E-01	1.143E-01	-0.94211	0.70925	0.149

Type II - OTHER SPECIES IN SOLUTION OR ADSORBED

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
5009690	Na EDTA	5.867E-07	2.664E-08	-7.57441	0.04541	3.843
3300020	OH-	1.484E-05	1.053E-05	-4.97772	0.70925	-13.816
4603300	MgOH +	4.543E-09	3.222E-09	-8.49188	0.70925	-11.597
4601400	MgCO3 AQ	7.980E-06	8.756E-06	-5.05772	1.09718	2.946
4601401	MgHCO3 +	3.157E-06	2.239E-06	-5.64992	0.70925	11.538
1503300	CaOH +	3.034E-11	2.152E-11	-10.66715	0.70925	-12.413
1501400	CaHCO3 +	1.261E-07	8.944E-08	-7.04848	0.70925	11.499
1501401	CaCO3 AQ	5.237E-07	5.746E-07	-6.24062	1.09718	3.122
5001400	NaCO3 -	3.647E-02	2.586E-02	-1.58730	0.70925	1.439
5001401	NaHCO3 AQ	1.471E-02	1.614E-02	-1.79198	1.09718	10.040
3301400	HCO3 -	1.460E-01	1.035E-01	-0.98495	0.70925	10.470
3301401	H2CO3 AQ	2.161E-04	2.371E-04	-3.62512	1.09718	16.635
3309691	EDTAH	6.306E-08	2.864E-09	-8.54304	0.04541	11.303
3309692	EDTAH2	2.037E-11	5.154E-12	-11.28789	0.25304	16.807
3309693	EDTAH3	3.284E-18	2.330E-18	-17.63273	0.70925	19.009
3309694	EDTAH4	2.524E-25	2.770E-25	-24.55758	1.09718	20.890
3309695	EDTA H5	1.351E-31	9.585E-32	-31.01842	0.70925	23.613
1509690	Ca EDTA	2.490E-04	6.302E-05	-4.20055	0.25304	12.997
1509691	CaHEDTA	3.579E-10	2.539E-10	-9.59540	0.70925	16.149
4609690	Mg EDTA	9.024E-05	2.284E-05	-4.64139	0.25304	11.197
4609691	MgHEDTA	1.030E-09	7.307E-10	-9.13624	0.70925	15.249

Type III - SPECIES WITH FIXED ACTIVITY

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
2	H2O	-1.485E-05	-4.828	0.007	0.000

Type IV - FINITE SOLIDS (present at equilibrium)

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
5046002	MAGNESITE	3.113E-04	-3.507	8.044	6.169

Type V - UNDERSATURATED SOLIDS (not present at equilibrium)

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
5046000	ARTINITE	4.431E-06	-5.353	-9.530	28.742
2046000	BRUCITE	3.261E-05	-4.487	-16.729	25.840
5015001	CALCITE	1.197E-01	-0.922	8.481	2.585
5015002	DOLOMITE	3.740E-01	-0.427	17.020	8.290
4150000	HALITE	2.508E-06	-5.601	-1.584	-0.918
5015003	HUNTITE	3.130E-04	-3.505	30.031	25.760
5046001	HYDRMAGNESIT	8.520E-12	-11.070	8.894	52.210
5015000	ARAGONITE	8.748E-02	-1.058	8.345	2.615
3050000	NATRON	5.708E-03	-2.243	1.272	-15.745
5046003	NESQUEHONITE	3.709E-03	-2.431	5.635	5.789
5050001	THERMONATR	2.699E-04	-3.569	-0.118	2.802
2015000	LIME	1.609E-22	-21.794	-32.684	46.265
2015001	PORTLANDITE	1.919E-12	-11.717	-22.600	30.690
2046001	PERICLASE	6.726E-10	-9.172	-21.421	36.135

Type VI - EXCLUDED SPECIES (not included in mole balance)

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
3301403	CO2 (g)	7.334E-03	-2.135	18.159	-0.530

PERCENTAGE DISTRIBUTION OF COMPONENTS AMONG
TYPE I and TYPE II (dissolved and adsorbed) species

H+1
9.1 PERCENT BOUND IN SPECIES #5001401 NaHCO3 AQ

90.6 PERCENT BOUND IN SPECIES #3301400 HCO3 -

Na+1
88.2 PERCENT BOUND IN SPECIES # 500 Na+1

8.4 PERCENT BOUND IN SPECIES #5001400 NaCO3 -

3.4 PERCENT BOUND IN SPECIES #5001401 NaHCO3 AQ

CO3-2
8.9 PERCENT BOUND IN SPECIES # 140 CO3-2

16.8 PERCENT BOUND IN SPECIES #5001400 NaCO3 -

6.8 PERCENT BOUND IN SPECIES #5001401 NaHCO3 AQ

67.4 PERCENT BOUND IN SPECIES #3301400 HCO3 -

Ca+2
99.6 PERCENT BOUND IN SPECIES #1509690 Ca EDTA

Cl-1
100.0 PERCENT BOUND IN SPECIES # 180 Cl-1

NO3-1
100.0 PERCENT BOUND IN SPECIES # 492 NO3-1

EDTA-4
73.2 PERCENT BOUND IN SPECIES #1509690 Ca EDTA

26.5 PERCENT BOUND IN SPECIES #4609690 Mg EDTA

H2O
100.0 PERCENT BOUND IN SPECIES #3300020 OH-

Mg+2
6.7 PERCENT BOUND IN SPECIES # 460 Mg+2

7.3 PERCENT BOUND IN SPECIES #4601400 MgCO3 AQ

2.9 PERCENT BOUND IN SPECIES #4601401 MgHCO3 +

83.0 PERCENT BOUND IN SPECIES #4609690 Mg EDTA

----------- EQUILIBRATED MASS DISTRIBUTION -----------

IDX	NAME	DISSOLVED		SORBED		PRECIPITATED	
		MOL/KG	PERCENT	MOL/KG	PERCENT	MOL/KG	PERCENT
330	H+1	1.611E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
500	Na+1	4.340E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
140	CO3-2	2.167E-01	99.9	0.000E-01	0.0	3.113E-04	0.1
150	Ca+2	2.500E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
180	Cl-1	5.000E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
492	NO3-1	1.611E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
969	EDTA-4	3.400E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
2	H2O	1.485E-05	100.0	0.000E-01	0.0	0.000E-01	0.0
460	Mg+2	1.087E-04	25.9	0.000E-01	0.0	3.113E-04	74.1

Charge Balance: SPECIATED

Sum of CATIONS = 3.828E-01 Sum of ANIONS 3.834E-01

PERCENT DIFFERENCE = 6.788E-02 (ANIONS - CATIONS)/(ANIONS + CATIONS)

EQUILIBRIUM IONIC STRENGTH (m) = 4.028E-01

EQUILIBRIUM pH = 8.995

DATE ID NUMBER: 940908
TIME ID NUMBER: 8363879

Saturation indices and stoichiometry of all minerals

ID #	NAME	Sat. Index	Stoichiometry in [brackets]		
5015000	ARAGONITE	-1.058	[1.000] 150	[1.000] 140	
5046000	ARTINITE	-5.353	[-2.000] 330	[2.000] 460	[1.000] 140
			[5.000] 2		
2046000	BRUCITE	-4.487	[1.000] 460	[2.000] 2	[-2.000] 330
5015001	CALCITE	-0.922	[1.000] 150	[1.000] 140	
5015002	DOLOMITE	-0.427	[1.000] 150	[1.000] 460	[2.000] 140
4150000	HALITE	-5.601	[1.000] 500	[1.000] 180	
5015003	HUNTITE	-3.505	[3.000] 460	[1.000] 150	[4.000] 140
5046001	HYDRMAGNESIT	-11.070	[5.000] 460	[4.000] 140	[-2.000] 330
			[6.000] 2		
5046002	MAGNESITE	0.000	[1.000] 460	[1.000] 140	
3050000	NATRON	-2.243	[2.000] 500	[1.000] 140	[10.000] 2
5046003	NESQUEHONITE	-2.431	[1.000] 460	[1.000] 140	[3.000] 2
5050001	THERMONATR	-3.569	[2.000] 500	[1.000] 140	[1.000] 2
2015000	LIME	-21.794	[-2.000] 330	[1.000] 150	[1.000] 2
2015001	PORTLANDITE	-11.717	[-2.000] 330	[1.000] 150	[2.000] 2
2046001	PERICLASE	-9.172	[-2.000] 330	[1.000] 460	[1.000] 2

Run 5 - 10 g/l Na; 10 mg/l Ca and Mg; 0,1 g/l EDTA; sample 2; pH 7.8
add HNO3; allow ppt

Type I - COMPONENTS AS SPECIES IN SOLUTION

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
330	H+1	2.321E-08	1.645E-08	-7.78376	0.70880	0.149
500	Na+1	4.107E-01	2.911E-01	-0.53594	0.70880	0.149
140	CO3-2	1.528E-03	3.858E-04	-3.41364	0.25240	0.598
150	Ca+2	3.738E-06	9.434E-07	-6.02531	0.25240	0.598
180	Cl-1	5.000E-04	3.544E-04	-3.45051	0.70880	0.149
460	Mg+2	9.278E-05	2.342E-05	-4.63047	0.25240	0.598
969	EDTA-4	6.400E-09	2.598E-11	-10.58541	0.00406	2.392
492	NO3-1	2.167E-01	1.536E-01	-0.81362	0.70880	0.149

Type II - OTHER SPECIES IN SOLUTION OR ADSORBED

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
5009690	Na EDTA	5.296E-08	2.391E-09	-8.62135	0.04516	3.845
3300020	OH-	9.117E-07	6.462E-07	-6.18964	0.70880	-13.816
4603300	MgOH +	3.535E-09	2.506E-09	-8.60108	0.70880	-11.597
4601400	MgCO3 AQ	7.961E-06	8.756E-06	-5.05772	1.09981	2.945
4601401	MgHCO3 +	5.136E-05	3.641E-05	-4.43883	0.70880	11.539
1503300	CaOH +	2.175E-11	1.542E-11	-10.81203	0.70880	-12.413
1501400	CaHCO3 +	1.890E-06	1.339E-06	-5.87306	0.70880	11.499
1501401	CaCO3 AQ	4.813E-07	5.293E-07	-6.27629	1.09981	3.121
5001400	NaCO3 -	3.088E-03	2.189E-03	-2.65975	0.70880	1.439
5001401	NaHCO3 AQ	2.020E-02	2.222E-02	-1.65334	1.09981	10.039
3301400	HCO3 -	1.875E-01	1.329E-01	-0.87659	0.70880	10.470
3301401	H2CO3 AQ	4.498E-03	4.947E-03	-2.30566	1.09981	16.634
3309691	EDTAH	8.632E-08	3.898E-09	-8.40917	0.04516	11.305
3309692	EDTAH2	4.518E-10	1.140E-10	-9.94293	0.25240	16.808
3309693	EDTAH3	1.182E-15	8.381E-16	-15.07668	0.70880	19.009
3309694	EDTAH4	1.473E-21	1.620E-21	-20.79044	1.09981	20.889
3309695	EDTA H5	1.286E-26	9.116E-27	-26.04020	0.70880	23.613
1509690	Ca EDTA	2.439E-04	6.156E-05	-4.21072	0.25240	12.998
1509691	CaHEDTA	5.689E-09	4.032E-09	-8.39448	0.70880	16.149
4609690	Mg EDTA	9.594E-05	2.422E-05	-4.61588	0.25240	11.198
4609691	MgHEDTA	1.778E-08	1.260E-08	-7.89964	0.70880	15.249

Type III - SPECIES WITH FIXED ACTIVITY

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
2	H2O	-9.152E-07	-6.038	0.008	0.000

Type IV - FINITE SOLIDS (present at equilibrium)

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
5046002	MAGNESITE	1.719E-04	-3.765	8.044	6.169

Type V - UNDERSATURATED SOLIDS (not present at equilibrium)

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
5046000	ARTINITE	2.103E-07	-6.677	-9.530	28.742
2046000	BRUCITE	1.557E-06	-5.808	-16.729	25.840
5015001	CALCITE	1.103E-01	-0.958	8.481	2.585
5015002	DOLOMITE	3.445E-01	-0.463	17.020	8.290
4150000	HALITE	2.687E-06	-5.571	-1.584	-0.918
5015003	HUNTITE	2.883E-04	-3.540	30.031	25.760
5046001	HYDRMAGNESIT	4.036E-13	-12.394	8.894	52.210
5015000	ARAGONITE	8.059E-02	-1.094	8.345	2.615
3050000	NATRON	5.081E-04	-3.294	1.272	-15.745
5046003	NESQUEHONITE	3.688E-03	-2.433	5.635	5.789
5050001	THERMONATR	2.445E-05	-4.612	-0.118	2.802
2015000	LIME	7.087E-24	-23.150	-32.684	46.265
2015001	PORTLANDITE	8.438E-14	-13.074	-22.600	30.690
2046001	PERICLASE	3.217E-11	-10.493	-21.421	36.135

Type VI - EXCLUDED SPECIES (not included in mole balance)

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
3301403	CO2 (g)	1.533E-01	-0.814	18.159	-0.530

PERCENTAGE DISTRIBUTION OF COMPONENTS AMONG
TYPE I and TYPE II (dissolved and adsorbed) species

H+1				
	9.3	PERCENT BOUND IN SPECIES	#5001401	NaHCO3 AQ
	86.5	PERCENT BOUND IN SPECIES	#3301400	HCO3 -
	4.2	PERCENT BOUND IN SPECIES	#3301401	H2CO3 AQ
Na+1				
	94.6	PERCENT BOUND IN SPECIES	# 500	Na+1
	4.7	PERCENT BOUND IN SPECIES	#5001401	NaHCO3 AQ
CO3-2				
	1.4	PERCENT BOUND IN SPECIES	#5001400	NaCO3 -
	9.3	PERCENT BOUND IN SPECIES	#5001401	NaHCO3 AQ
	86.5	PERCENT BOUND IN SPECIES	#3301400	HCO3 -
	2.1	PERCENT BOUND IN SPECIES	#3301401	H2CO3 AQ
Ca+2				
	1.5	PERCENT BOUND IN SPECIES	# 150	Ca+2
	97.6	PERCENT BOUND IN SPECIES	#1509690	Ca EDTA
Cl-1				
	100.0	PERCENT BOUND IN SPECIES	# 180	Cl-1
NO3-1				
	100.0	PERCENT BOUND IN SPECIES	# 492	NO3-1
EDTA-4				
	71.7	PERCENT BOUND IN SPECIES	#1509690	Ca EDTA
	28.2	PERCENT BOUND IN SPECIES	#4609690	Mg EDTA
H2O				
	99.6	PERCENT BOUND IN SPECIES	#3300020	OH-
Mg+2				
	37.4	PERCENT BOUND IN SPECIES	# 460	Mg+2
	3.2	PERCENT BOUND IN SPECIES	#4601400	MgCO3 AQ
	20.7	PERCENT BOUND IN SPECIES	#4601401	MgHCO3 +
	38.7	PERCENT BOUND IN SPECIES	#4609690	Mg EDTA

----------- EQUILIBRATED MASS DISTRIBUTION -----------

IDX	NAME	DISSOLVED		SORBED		PRECIPITATED	
		MOL/KG	PERCENT	MOL/KG	PERCENT	MOL/KG	PERCENT
330	H+1	2.167E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
500	Na+1	4.340E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
140	CO3-2	2.168E-01	99.9	0.000E-01	0.0	1.719E-04	0.1
150	Ca+2	2.500E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
180	Cl-1	5.000E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
492	NO3-1	2.167E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
969	EDTA-4	3.400E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
2	H2O	9.152E-07	100.0	0.000E-01	0.0	0.000E-01	0.0
460	Mg+2	2.481E-04	59.1	0.000E-01	0.0	1.719E-04	40.9

Charge Balance: SPECIATED

Sum of CATIONS = 4.110E-01 Sum of ANIONS 4.115E-01

PERCENT DIFFERENCE = 6.323E-02 (ANIONS - CATIONS)/(ANIONS + CATIONS)

EQUILIBRIUM IONIC STRENGTH (m) = 4.132E-01

EQUILIBRIUM pH = 7.784

DATE ID NUMBER: 940908
TIME ID NUMBER: 8335138

Saturation indices and stoichiometry of all minerals

ID #	NAME	Sat. Index	Stoichiometry in [brackets]					
5015000	ARAGONITE	-1.094	[1.000]	150	[1.000]	140		
5046000	ARTINITE	-6.677	[-2.000]	330	[2.000]	460	[1.000]	140
			[5.000]	2				
2046000	BRUCITE	-5.808	[1.000]	460	[2.000]	2	[-2.000]	330
5015001	CALCITE	-0.958	[1.000]	150	[1.000]	140		
5015002	DOLOMITE	-0.463	[1.000]	150	[1.000]	460	[2.000]	140
4150000	HALITE	-5.571	[1.000]	500	[1.000]	180		
5015003	HUNTITE	-3.540	[3.000]	460	[1.000]	150	[4.000]	140
5046001	HYDRMAGNESIT	-12.394	[5.000]	460	[4.000]	140	[-2.000]	330
			[6.000]	2				
5046002	MAGNESITE	0.000	[1.000]	460	[1.000]	140		
3050000	NATRON	-3.294	[2.000]	500	[1.000]	140	[10.000]	2
5046003	NESQUEHONITE	-2.433	[1.000]	460	[1.000]	140	[3.000]	2
5050001	THERMONATR	-4.612	[2.000]	500	[1.000]	140	[1.000]	2
2015000	LIME	-23.150	[-2.000]	330	[1.000]	150	[1.000]	2
2015001	PORTLANDITE	-13.074	[-2.000]	330	[1.000]	150	[2.000]	2
2046001	PERICLASE	-10.493	[-2.000]	330	[1.000]	460	[1.000]	2

Run 5 - 10 g/l Na; 10 mg/l Ca and Mg; 0,1 g/l EDTA; sample 5; pH 7,2
add HNO3; allow ppt

Type I - COMPONENTS AS SPECIES IN SOLUTION

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
330	H+1	1.278E-07	9.056E-08	-7.04305	0.70868	0.150
500	Na+1	4.145E-01	2.938E-01	-0.53197	0.70868	0.150
140	CO3-2	2.582E-04	6.512E-05	-4.18630	0.25224	0.598
150	Ca+2	7.779E-06	1.962E-06	-5.70726	0.25224	0.598
180	Cl-1	5.000E-04	3.543E-04	-3.45058	0.70868	0.150
460	Mg+2	2.085E-04	5.258E-05	-4.27916	0.25224	0.598
969	EDTA-4	3.014E-09	1.220E-11	-10.91369	0.00405	2.393
492	NO3-1	2.392E-01	1.695E-01	-0.77079	0.70868	0.150

Type II - OTHER SPECIES IN SOLUTION OR ADSORBED

ID	NAME	CALC MOL	ACTIVITY	LOG ACTVTY	GAMMA	NEW LOGK
5009690	Na EDTA	2.513E-08	1.133E-09	-8.94566	0.04509	3.846
3300020	OH-	1.655E-07	1.173E-07	-6.93069	0.70868	-13.816
4603300	MgOH +	1.441E-09	1.021E-09	-8.99082	0.70868	-11.597
4601400	MgCO3 AQ	3.015E-06	3.319E-06	-5.47906	1.10057	2.945
4601401	MgHCO3 +	1.072E-04	7.595E-05	-4.11946	0.70868	11.539
1503300	CaOH +	8.213E-12	5.821E-12	-11.23503	0.70868	-12.413
1501400	CaHCO3 +	3.652E-06	2.588E-06	-5.58696	0.70868	11.499
1501401	CaCO3 AQ	1.688E-07	1.858E-07	-6.73090	1.10057	3.121
5001400	NaCO3 -	5.262E-04	3.729E-04	-3.42844	0.70868	1.439
5001401	NaHCO3 AQ	1.893E-02	2.083E-02	-1.68132	1.10057	10.038
3301400	HCO3 -	1.742E-01	1.234E-01	-0.90853	0.70868	10.470
3301401	H2CO3 AQ	2.299E-02	2.530E-02	-1.59690	1.10057	16.634
3309691	EDTAH	2.235E-07	1.008E-08	-7.99673	0.04509	11.306
3309692	EDTAH2	6.433E-09	1.623E-09	-8.78978	0.25224	16.808
3309693	EDTAH3	9.262E-14	6.564E-14	-13.18283	0.70868	19.010
3309694	EDTAH4	6.346E-19	6.984E-19	-18.15588	1.10057	20.888
3309695	EDTA H5	3.052E-23	2.163E-23	-22.66493	0.70868	23.614
1509690	Ca EDTA	2.384E-04	6.013E-05	-4.22094	0.25224	12.998
1509691	CaHEDTA	3.059E-08	2.168E-08	-7.66399	0.70868	16.150
4609690	Mg EDTA	1.012E-04	2.554E-05	-4.59284	0.25224	11.198
4609691	MgHEDTA	1.032E-07	7.313E-08	-7.13589	0.70868	15.250

Type III - SPECIES WITH FIXED ACTIVITY

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
2	H2O	-1.670E-07	-6.777	0.008	0.000

Type V - UNDERSATURATED SOLIDS (not present at equilibrium)

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
5015000	ARAGONITE	2.829E-02	-1.548	8.345	2.615
5046000	ARTINITE	5.885E-09	-8.230	-9.530	28.742
2046000	BRUCITE	1.152E-07	-6.939	-16.729	25.840
5015001	CALCITE	3.871E-02	-1.412	8.481	2.585
5015002	DOLOMITE	4.585E-02	-1.339	17.020	8.290
4150000	HALITE	2.711E-06	-5.567	-1.584	-0.918
5015003	HUNTITE	5.511E-06	-5.259	30.031	25.760
5046001	HYDRMAGNESIT	6.144E-16	-15.212	8.894	52.210
5046002	MAGNESITE	3.790E-01	-0.421	8.044	6.169
3050000	NATRON	8.667E-05	-4.062	1.272	-15.745
5046003	NESQUEHONITE	1.395E-03	-2.856	5.635	5.789
5050001	THERMONATR	4.199E-06	-5.377	-0.118	2.802
2015000	LIME	4.861E-25	-24.313	-32.684	46.265
2015001	PORTLANDITE	5.783E-15	-14.238	-22.600	30.690
2046001	PERICLASE	2.383E-12	-11.623	-21.421	36.135

Type VI - EXCLUDED SPECIES (not included in mole balance)

ID	NAME	CALC MOL	LOG MOL	NEW LOGK	DH
3301403	CO2 (g)	7.848E-01	-0.105	18.159	-0.530

PERCENTAGE DISTRIBUTION OF COMPONENTS AMONG
TYPE I and TYPE II (dissolved and adsorbed) species

H+1

7.9	PERCENT BOUND IN SPECIES	#5001401	NaHCO3 AQ
72.8	PERCENT BOUND IN SPECIES	#3301400	HCO3 -
19.2	PERCENT BOUND IN SPECIES	#3301401	H2CO3 AQ

Na+1

95.5	PERCENT BOUND IN SPECIES	# 500	Na+1
4.4	PERCENT BOUND IN SPECIES	#5001401	NaHCO3 AQ

CO3-2

8.7	PERCENT BOUND IN SPECIES	#5001401	NaHCO3 AQ
80.3	PERCENT BOUND IN SPECIES	#3301400	HCO3 -
10.6	PERCENT BOUND IN SPECIES	#3301401	H2CO3 AQ

Ca+2

3.1	PERCENT BOUND IN SPECIES	# 150	Ca+2
1.5	PERCENT BOUND IN SPECIES	#1501400	CaHCO3 +
95.3	PERCENT BOUND IN SPECIES	#1509690	Ca EDTA

Cl-1

100.0	PERCENT BOUND IN SPECIES	# 180	Cl-1

Mg+2

49.6	PERCENT BOUND IN SPECIES	# 460	Mg+2
25.5	PERCENT BOUND IN SPECIES	#4601401	MgHCO3 +
24.1	PERCENT BOUND IN SPECIES	#4609690	Mg EDTA

EDTA-4

70.1	PERCENT BOUND IN SPECIES	#1509690	Ca EDTA
29.8	PERCENT BOUND IN SPECIES	#4609690	Mg EDTA

NO3-1

100.0	PERCENT BOUND IN SPECIES	# 492	NO3-1

H2O

99.1	PERCENT BOUND IN SPECIES	#3300020	OH-

----------- EQUILIBRATED MASS DISTRIBUTION -----------

IDX	NAME	DISSOLVED MOL/KG	DISSOLVED PERCENT	SORBED MOL/KG	SORBED PERCENT	PRECIPITATED MOL/KG	PRECIPITATED PERCENT
330	H+1	2.392E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
500	Na+1	4.340E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
140	CO3-2	2.170E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
150	Ca+2	2.500E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
180	Cl-1	5.000E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
460	Mg+2	4.200E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
969	EDTA-4	3.400E-04	100.0	0.000E-01	0.0	0.000E-01	0.0
492	NO3-1	2.392E-01	100.0	0.000E-01	0.0	0.000E-01	0.0
2	H2O	1.670E-07	100.0	0.000E-01	0.0	0.000E-01	0.0

Charge Balance: SPECIATED

Sum of CATIONS = 4.151E-01 Sum of ANIONS 4.156E-01

PERCENT DIFFERENCE = 6.260E-02 (ANIONS - CATIONS)/(ANIONS + CATIONS)

EQUILIBRIUM IONIC STRENGTH (m) = 4.162E-01

EQUILIBRIUM pH = 7.043

DATE ID NUMBER: 940908
TIME ID NUMBER: 8323816

Saturation indices and stoichiometry of all minerals

ID #	NAME	Sat. Index	Stoichiometry in [brackets]		
5015000	ARAGONITE	-1.548	[1.000] 150	[1.000] 140	
5046000	ARTINITE	-8.230	[-2.000] 330	[2.000] 460	[1.000] 140
			[5.000] 2		
2046000	BRUCITE	-6.939	[1.000] 460	[2.000] 2	[-2.000] 330
5015001	CALCITE	-1.412	[1.000] 150	[1.000] 140	
5015002	DOLOMITE	-1.339	[1.000] 150	[1.000] 460	[2.000] 140
4150000	HALITE	-5.567	[1.000] 500	[1.000] 180	
5015003	HUNTITE	-5.259	[3.000] 460	[1.000] 150	[4.000] 140
5046001	HYDRMAGNESIT	-15.212	[5.000] 460	[4.000] 140	[-2.000] 330
			[6.000] 2		
5046002	MAGNESITE	-0.421	[1.000] 460	[1.000] 140	
3050000	NATRON	-4.062	[2.000] 500	[1.000] 140	[10.000] 2
5046003	NESQUEHONITE	-2.856	[1.000] 460	[1.000] 140	[3.000] 2
5050001	THERMONATR	-5.377	[2.000] 500	[1.000] 140	[1.000] 2
2015000	LIME	-24.313	[-2.000] 330	[1.000] 150	[1.000] 2
2015001	PORTLANDITE	-14.238	[-2.000] 330	[1.000] 150	[2.000] 2
2046001	PERICLASE	-11.623	[-2.000] 330	[1.000] 460	[1.000] 2

Results of Transport Modeling

DATA PREPARATION FOR PREMSEP

For Experiment 7:
Feed Speciation:
The speciated data from table A7.11 were used. Small adjustments were made to ensure electroneutrality of the feed as required by the model. In the case of the pH 11.3 dataset, it was assumed that the nitrate figure in table A7.11 was an error, and that no nitric acid had been added. The speciation was re-run for the nominal amount of sodium carbonate alone in water (10g/l as Na, ie 10/(23x2) molar.

Permeate :
The measured data for the permeate is not used directly by the model, but only compared to the model predictions. The data was entered in terms of 'indicators' which represent the actual measurements made. For the three indicators used their total concentrations respectively were calculated from the data given in table A7-7 as follows
Carbonate Indicator conc. : (CO3=/60 + HCO3-/61)/1000 mol/l
Sodium Indicator conc. : (Na+/23)/1000 mol/l
Hydrogen Indicator conc. : (HCO3-/61)/1000 mol/l
In fact the values were entered into PREMSEP mol/m3, although they have been graphed as mol/l.
The values for concs. of HCO3-, CO3= and Na+ were taken from table A7-7

For Experiment 9:
Feed Speciation:
The feed for this experiment was 10g/l Na as Sodium Carbonate, at a constant pH of 9.6. So it was only necessary to speciate the feed once using the above details. What about NO3-? From the speciation done, the amount of dissolved H+ was inputted into a new speciation run, the equivalent amount of NO3- was included and the pH was left to be computed (assumption: free hydrogen came from addition of HNO3).

Permeate Speciation:
The same procedure as that for permeate speciation of experiment 7 was used here, with the values for concs of HCO3-, CO3= and Na+ now being taken from table A7-9.

PREMSEP : PARAMETERS (For Experiments 7 and 9)

Pure Water Permeability			1.08E-14
Correction Coefficient			0
Charge Density			-600
Transport Parameters:			
Species	Parameter 1	Parameter2	Parameter3
CO3=	1	0.5	1
H+	0.9	20	1
H2CO3	1	0.5	1
HCO3-	0.8	1.2	1
Na+	0.95	18	1
NaCO3-	1	0.12	1
NaHCO3	1	4	1
NO3-	0.93	16	1
OH-	1	20	1

Parameters

1 Reflection coefficient, dimensionless
2 Solute permeability in the membrane
3 Equilibrium partition coefficient

Combined experiment 7 and run 9 PREMSEP INPUT

Feed

Flow m3/s	Time	Temp C	Press Pa	Not used	Not used	H+ mol/m3	Na+ mol/m3	CO3= mol/m3	NO3- mol/m3	H2CO3 mol/m3	OH- mol/m3	NaCO3- mol/m3	NaHCO3 mol/m3	HCO3- mol/m3	Sodium	Carbonate	Hydrogen
0.000017	0	26	1300000	0	0	7.1E-09	305.2619	85.06	0.4389	0.000023	3.011	128.5	0.2578	3.192	0	0	0
0.000017	0	26	1300000	0	0	3.5E-08	311.0299	79.11	15.52	0.00055	0.5999	121.8	1.225	14.89	0	0	0
0.000017	0	26	1300000	0	0	3.6E-07	348.0496	45.36	93.54	0.03171	0.05962	78.07	7.878	85.66	0	0	0
0.000017	0	26	1300000	0	0	1.4E-06	382.7349	19.4	161.2	0.2155	0.0149	36.62	14.72	146.1	0	0	0
0.000017	0	26	1300000	0	0	7.1E-06	405.067	4.823	203.9	1.342	0.002967	9.618	19.35	181.9	0	0	0
0.000017	0	26	1300000	0	0	0.000092	413.792	0.3697	232.9	17.03	0.00023	0.7525	19.47	179.4	0	0	0
0.007417	0	26	400000	0	0	3.3E-07	359.5	46.94	103.4	0.03404	0.04756	67.05	8.279	95.1	0	0	0
0.016833	0	26	400000	0	0	3.3E-07	359.5	46.94	103.4	0.03404	0.04756	67.05	8.279	95.1	0	0	0
0.026833	0	26	400000	0	0	3.3E-07	359.5	46.94	103.4	0.03404	0.04756	67.05	8.279	95.1	0	0	0
0.007417	0	26	850000	0	0	3.3E-07	359.5	46.94	103.4	0.03404	0.04756	67.05	8.279	95.1	0	0	0
0.016833	0	26	850000	0	0	3.3E-07	359.5	46.94	103.4	0.03404	0.04756	67.05	8.279	95.1	0	0	0
0.026833	0	26	850000	0	0	3.3E-07	359.5	46.94	103.4	0.03404	0.04756	67.05	8.279	95.1	0	0	0
0.007417	0	26	1500000	0	0	3.3E-07	359.5	46.94	103.4	0.03404	0.04756	67.05	8.279	95.1	0	0	0
0.016833	0	26	1500000	0	0	3.3E-07	359.5	46.94	103.4	0.03404	0.04756	67.05	8.279	95.1	0	0	0
0.026833	0	26	1500000	0	0	3.3E-07	359.5	46.94	103.4	0.03404	0.04756	67.05	8.279	95.1	0	0	0

Permeate

Flow m3/s	Time	Temp C	Press Pa	Not used	Not used	H+ mol/m3	Na+ mol/m3	CO3= mol/m3	NO3- mol/m3	H2CO3 mol/m3	OH- mol/m3	NaCO3- mol/m3	NaHCO3 mol/m3	HCO3- mol/m3	Sodium	Carbonate	Hydrogen
2.0E-08	0	26	0	0	0	0	0	0	0	0	0	0	0	0	89.13043	70.34153	4.508197
3.3E-08	0	26	0	0	0	0	0	0	0	0	0	0	0	0	124.3478	57.55027	21.98361
4.6E-08	0	26	0	0	0	0	0	0	0	0	0	0	0	0	230.4348	76	66
5.3E-08	0	26	0	0	0	0	0	0	0	0	0	0	0	0	317.3913	94.65574	94.65574
5.3E-08	0	26	0	0	0	0	0	0	0	0	0	0	0	0	354.3478	110.6557	110.6557
5.3E-08	0	26	0	0	0	0	0	0	0	0	0	0	0	0	354.3478	102.6557	102.6557
7.6E-09	0	26	0	0	0	0	0	0	0	0	0	0	0	0	302.243	142.3643	111.643
6.9E-09	0	26	0	0	0	0	0	0	0	0	0	0	0	0	306.539	149.3658	110.939
5.6E-09	0	26	0	0	0	0	0	0	0	0	0	0	0	0	295.742	146.1574	109.092
2.5E-08	0	26	0	0	0	0	0	0	0	0	0	0	0	0	234.797	100.1958	80.747
2.5E-08	0	26	0	0	0	0	0	0	0	0	0	0	0	0	247.796	101.694	81.486
2.4E-08	0	26	0	0	0	0	0	0	0	0	0	0	0	0	254.261	98.6036	78.781
5.8E-08	0	26	0	0	0	0	0	0	0	0	0	0	0	0	321.662	74.4044	60.457
5.9E-08	0	26	0	0	0	0	0	0	0	0	0	0	0	0	334.844	69.8015	56.457
5.4E-08	0	26	0	0	0	0	0	0	0	0	0	0	0	0	321.725	69.6024	56.546

Combined experiment 7 and run 9

Permeate

Frate m3/s	rFrate m3/s	Temp deg C	rTemp deg C	Press Pa	rPress Pa	Cond Not Used	rCond Not Used	OsPress Not Used	rOsPress Not Used	H+ gmol/m3	rH+ rgmol/m3	Na+ gmol/m3	rNa+ rgmol/m3	CO3= gmol/m3	rCO3= rgmol/m3	NO3- gmol/m3	rNO3- rgmol/m3	H2CO3 gmol/m3	rH2CO3 rgmol/m3	OH- gmol/m3	rOH- rgmol/m3	NaCO3- gmol/m3	rNaCO3- rgmol/m3	NaHCO3 gmol/m3	rNaHCO3 rgmol/m3	HCO3- gmol/m3	rHCO3- rgmol/m3	Sodium gmol/m3?	rSodium rgmol/m3?	Carbonate gmol/m3?	rCarbonate rgmol/m3?	Hydrogen gmol/m3?	rHydrogen rgmol/m3?
2.3E-08	2.0E-08	26	26	0	0	0	0	0	0	1.9E-09	0	86.89372	0	26.68768	0	1.231995	0	0.000014	0	9.120968	0	19.65749	0	0.23613	0	3.507906	0	106.7873	89.13044	50.08922	70.34153	12.86502	4.508197
2.8E-08	3.3E-08	26	26	0	0	0	0	0	0	1.2E-08	0	110.1976	0	21.42941	0	35.88722	0	0.000295	0	1.484961	0	16.00468	0	1.105807	0	13.9671	0	127.308	124.3478	52.50729	57.55027	16.55816	21.98361
4.2E-08	4.6E-08	26	26	0	0	0	0	0	0	2.1E-07	0	213.3527	0	6.796941	0	132.8491	0	0.014061	0	0.088301	0	7.265517	0	6.809612	0	55.54964	0	227.4278	230.4348	78.43577	76	62.46162	66
4.9E-08	5.3E-08	26	26	0	0	0	0	0	0	1.0E-06	0	284.9538	0	3.38186	0	191.3967	0	0.088585	0	0.018231	0	3.04691	0	12.48424	0	83.70269	0	300.485	317.3913	102.7043	94.65574	96.29374	94.65574
5.3E-08	5.3E-08	26	26	0	0	0	0	0	0	5.6E-06	0	326.2607	0	0.807208	0	224.8696	0	0.53365	0	0.003351	0	0.765848	0	16.26946	0	99.19495	0	343.2961	354.3478	117.5711	110.6557	116.0014	110.6557
5.4E-08	5.3E-08	26	26	0	0	0	0	0	0	0.000075	0	344.6617	0	0.061014	0	248.5584	0	6.719657	0	0.000251	0	0.059224	0	18.33671	0	98.1187	0	361.2577	354.3478	119.2953	102.6557	119.1754	102.6557
8.4E-09	7.6E-09	26	26	0	0	0	0	0	0	2.7E-07	0	290.433	0	25.89399	0	124.9883	0	0.028565	0	0.057694	0	21.0402	0	7.997888	0	92.68787	0	319.4709	302.243	147.8263	142.3643	100.7498	111.643
8.4E-09	6.9E-09	26	26	0	0	0	0	0	0	2.7E-07	0	290.4303	0	25.89335	0	124.9893	0	0.026564	0	0.057695	0	21.03942	0	7.997872	0	92.66774	0	319.4874	306.539	147.8247	149.3658	100.7497	110.939
8.4E-09	5.6E-09	26	26	0	0	0	0	0	0	2.7E-07	0	290.4294	0	25.89315	0	124.9898	0	0.026584	0	0.057695	0	21.03917	0	7.997667	0	92.66771	0	319.4863	295.742	147.6243	146.1574	100.7498	109.092
2.5E-08	2.5E-08	26	26	0	0	0	0	0	0	2.3E-07	0	245.1776	0	12.19145	0	140.0578	0	0.018427	0	0.065241	0	8.669057	0	7.486098	0	72.00485	0	261.3328	234.797	100.3699	100.1958	79.57481	80.747
2.5E-08	2.5E-08	26	26	0	0	0	0	0	0	2.3E-07	0	245.1661	0	12.18996	0	140.0635	0	0.018425	0	0.065243	0	8.667814	0	7.485986	0	72.00213	0	261.3199	247.796	100.3643	101.894	79.57178	81.486
2.5E-08	2.4E-08	26	26	0	0	0	0	0	0	2.3E-07	0	245.1625	0	12.1895	0	140.0653	0	0.018425	0	0.065243	0	8.667427	0	7.485952	0	72.00128	0	261.3159	254.261	100.3626	98.8036	79.5709	78.781
5.6E-08	5.8E-08	26	26	0	0	0	0	0	0	1.9E-07	0	211.1789	0	6.086663	0	145.8847	0	0.011808	0	0.069115	0	4.165662	0	6.701696	0	48.88416	0	222.0442	0	65.84999	74.4044	55.66678	60.457
5.6E-08	5.9E-08	26	26	0	0	0	0	0	0	1.9E-07	0	211.1557	0	6.082752	0	145.8902	0	0.011804	0	0.069115	0	4.163292	0	6.701089	0	48.8677	0	222.0201	0	65.82663	69.8015	55.64971	56.457
5.6E-08	5.4E-08	26	26	0	0	0	0	0	0	1.9E-07	0	211.1468	0	6.082148	0	145.8949	0	0.011803	0	0.069116	0	4.162848	0	6.700951	0	48.86514	0	222.0106	0	65.82289	69.6024	55.64701	56.548

Feed

Frate m3/s	rFrate m3/s	Temp deg C	rTemp deg C	Press Pa	rPress Pa	Cond Not Used	rCond Not Used	OsPress Not Used	rOsPress Not Used	H+ gmol/m3	rH+ rgmol/m3	Na+ gmol/m3	rNa+ rgmol/m3	CO3= gmol/m3	rCO3= rgmol/m3	NO3- gmol/m3	rNO3- rgmol/m3	H2CO3 gmol/m3	rH2CO3 rgmol/m3	OH- gmol/m3	rOH- rgmol/m3	NaCO3- gmol/m3	rNaCO3- rgmol/m3	NaHCO3 gmol/m3	rNaHCO3 rgmol/m3	HCO3- gmol/m3	rHCO3- rgmol/m3	Sodium gmol/m3?	rSodium rgmol/m3?	Carbonate gmol/m3?	rCarbonate rgmol/m3?	Hydrogen gmol/m3?	rHydrogen rgmol/m3?
0.000017	0.000017	26	26	1300000	1300000	0	0	0	0	7.1E-09	7.1E-09	305.2819	305.2819	85.06	85.06	0.4389	0.4389	0.000023	0.000023	3.011	3.011	128.5	128.5	0.2578	0.2578	3.192	3.192	434.0197	0	217.0098	0	6.460823	0
0.000017	0.000017	26	26	1300000	1300000	0	0	0	0	3.5E-08	3.5E-08	311.0299	311.0299	79.11	79.11	15.52	15.52	0.00055	0.00055	0.5999	0.5999	121.8	121.8	1.225	1.225	14.89	14.89	434.0549	0	217.0256	0	16.71545	0
0.000017	0.000017	26	26	1300000	1300000	0	0	0	0	3.6E-07	3.6E-07	348.0496	348.0496	45.36	45.36	93.54	93.54	0.03171	0.03171	0.05962	0.05962	78.07	78.07	7.878	7.878	85.66	85.66	433.9976	0	216.9997	0	93.62933	0
0.000017	0.000017	26	26	1300000	1300000	0	0	0	0	1.4E-06	1.4E-06	382.7349	382.7349	19.4	19.4	161.2	161.2	0.2155	0.2155	0.0149	0.0149	36.62	36.62	14.72	14.72	146.1	146.1	434.0749	0	217.0555	0	161.0504	0
0.000017	0.000017	26	26	1300000	1300000	0	0	0	0	7.1E-06	7.1E-06	405.067	405.067	4.823	4.823	203.9	203.9	1.342	1.342	0.002987	0.002987	9.618	9.618	19.35	19.35	181.9	181.9	434.035	0	217.033	0	202.595	0
0.000017	0.000017	26	26	1300000	1300000	0	0	0	0	0.000092	0.000092	413.792	413.792	0.3697	0.3697	232.9	232.9	17.03	17.03	0.00023	0.00023	0.7525	0.7525	19.47	19.47	179.4	179.4	434.0145	0	217.0222	0	215.9003	0
0.007417	0.007417	26	26	400000	400000	0	0	0	0	3.3E-07	3.3E-07	359.5	359.5	46.94	46.94	103.4	103.4	0.03404	0.03404	0.04756	0.04756	67.05	67.05	8.279	8.279	95.1	95.1	434.829	0	217.403	0	103.4608	0
0.016833	0.016833	26	26	400000	400000	0	0	0	0	3.3E-07	3.3E-07	359.5	359.5	46.94	46.94	103.4	103.4	0.03404	0.03404	0.04756	0.04756	67.05	67.05	8.279	8.279	95.1	95.1	434.829	0	217.403	0	103.4606	0
0.026833	0.026833	26	26	400000	400000	0	0	0	0	3.3E-07	3.3E-07	359.5	359.5	46.94	46.94	103.4	103.4	0.03404	0.03404	0.04756	0.04756	67.05	67.05	8.279	8.279	95.1	95.1	434.829	0	217.403	0	103.4606	0
0.007417	0.007417	26	26	850000	850000	0	0	0	0	3.3E-07	3.3E-07	359.5	359.5	46.94	46.94	103.4	103.4	0.03404	0.03404	0.04756	0.04756	67.05	67.05	8.279	8.279	95.1	95.1	434.829	0	217.403	0	103.4606	0
0.016833	0.016833	26	26	850000	850000	0	0	0	0	3.3E-07	3.3E-07	359.5	359.5	46.94	46.94	103.4	103.4	0.03404	0.03404	0.04756	0.04756	67.05	67.05	8.279	8.279	95.1	95.1	434.829	0	217.403	0	103.4606	0
0.026833	0.026833	26	26	850000	850000	0	0	0	0	3.3E-07	3.3E-07	359.5	359.5	46.94	46.94	103.4	103.4	0.03404	0.03404	0.04756	0.04756	67.05	67.05	8.279	8.279	95.1	95.1	434.829	0	217.403	0	103.4606	0
0.007417	0.007417	26	26	1500000	1500000	0	0	0	0	3.3E-07	3.3E-07	359.5	359.5	46.94	46.94	103.4	103.4	0.03404	0.03404	0.04756	0.04756	67.05	67.05	8.279	8.279	95.1	95.1	434.829	0	217.403	0	103.4606	0
0.016833	0.016833	26	26	1500000	1500000	0	0	0	0	3.3E-07	3.3E-07	359.5	359.5	46.94	46.94	103.4	103.4	0.03404	0.03404	0.04756	0.04756	67.05	67.05	8.279	8.279	95.1	95.1	434.829	0	217.403	0	103.4606	0
0.026833	0.026833	26	26	1500000	1500000	0	0	0	0	3.3E-07	3.3E-07	359.5	359.5	46.94	46.94	103.4	103.4	0.03404	0.03404	0.04756	0.04756	67.05	67.05	8.279	8.279	95.1	95.1	434.829	0	217.403	0	103.4606	0

Reject

Frate m3/s	rFrate m3/s	Temp deg C	rTemp deg C	Press Pa	rPress Pa	Cond Not Used	rCond Not Used	OsPress Not Used	rOsPress Not Used	H+ gmol/m3	rH+ rgmol/m3	Na+ gmol/m3	rNa+ rgmol/m3	CO3= gmol/m3	rCO3= rgmol/m3	NO3- gmol/m3	rNO3- rgmol/m3	H2CO3 gmol/m3	rH2CO3 rgmol/m3	OH- gmol/m3	rOH- rgmol/m3	NaCO3- gmol/m3	rNaCO3- rgmol/m3	NaHCO3 gmol/m3	rNaHCO3 rgmol/m3	HCO3- gmol/m3	rHCO3- rgmol/m3	Sodium gmol/m3?	rSodium rgmol/m3?	Carbonate gmol/m3?	rCarbonate rgmol/m3?	Hydrogen gmol/m3?	rHydrogen rgmol/m3?
0.000017	0	26	0	1300000	0	0	0	0	0	7.1E-09	0	305.5662	0	85.14136	0	0.437795	0	0.000024	0	3.002484	0	128.6517	0	0.25783	0	3.19156	0	434.4758	0	217.2425	0	6.451898	0
0.000017	0	26	0	1300000	0	0	0	0	0	3.5E-08	0	311.3632	0	79.20574	0	15.48619	0	0.00055	0	0.598431	0	121.9756	0	1.225198	0	14.89153	0	434.564	0	217.2986	0	16.71571	0
0.000017	0	26	0	1300000	0	0	0	0	0	3.6E-07	0	348.3901	0	45.45241	0	93.44065	0	0.031755	0	0.059548	0	78.24895	0	7.8807	0	85.7361	0	434.5197	0	217.3499	0	93.70811	0
0.000017	0	26	0	1300000	0	0	0	0	0	1.4E-06	0	383.0232	0	19.44723	0	161.111	0	0.215874	0	0.01489	0	36.719	0	14.72659	0	146.284	0	434.4688	0	217.3927	0	161.2414	0
0.000017	0	26	0	1300000	0	0	0	0	0	7.1E-06	0	405.3152	0	4.835651	0	203.8346	0	1.344547	0	0.002968	0	9.645888	0	19.35971	0	182.1606	0	434.3208	0	217.3463	0	202.9678	0
0.000017	0	26	0	1300000	0	0	0	0	0	0.000092	0	414.0126	0	0.370688	0	232.8499	0	17.06299	0	0.00023	0	0.754718	0	19.48002	0	179.6664	0	434.2473	0	217.3349	0	216.2098	0
0.007417	0	26	0	400000	0	0	0	0	0	3.3E-07	0	359.5001	0	46.94002	0	103.4	0	0.03404	0	0.04756	0	67.05005	0	8.279	0	95.1	0	434.8291	0	217.4031	0	103.4606	0
0.016833	0	26	0	400000	0	0	0	0	0	3.3E-07	0	359.5	0	46.94001	0	103.4	0	0.03404	0	0.04756	0	67.05002	0	8.279	0	95.1	0	434.8291	0	217.4031	0	103.4606	0
0.026833	0	26	0	400000	0	0	0	0	0	3.3E-07	0	359.5	0	46.94001	0	103.4	0	0.03404	0	0.04756	0	67.05001	0	8.279	0	95.1	0	434.829	0	217.4031	0	103.4606	0
0.007417	0	26	0	850000	0	0	0	0	0	3.3E-07	0	359.5004	0	46.94012	0	103.3999	0	0.03404	0	0.04756	0	67.0502	0	8.279003	0	95.10006	0	434.8296	0	217.4034	0	103.4607	0
0.016833	0	26	0	850000	0	0	0	0	0	3.3E-07	0	359.5002	0	46.94005	0	103.3999	0	0.03404	0	0.04756	0	67.05009	0	8.279001	0	95.10004	0	434.8293	0	217.4032	0	103.4606	0
0.026833	0	26	0	850000	0	0	0	0	0	3.3E-07	0	359.5001	0	46.94003	0	103.4	0	0.03404	0	0.04756	0	67.05006	0	8.279001	0	95.10002	0	434.8292	0	217.4032	0	103.4606	0
0.007417	0	26	0	1500000	0	0	0	0	0	3.3E-07	0	359.5011	0	46.94031	0	103.3997	0	0.03404	0	0.04756	0	67.05048	0	8.279012	0	95.10035	0	434.8306	0	217.4042	0	103.461	0
0.016833	0	26	0	1500000	0	0	0	0	0	3.3E-07	0	359.5005	0	46.94014	0	103.3999	0	0.03404	0	0.04756	0	67.05021	0	8.279005	0	95.10015	0	434.8297	0	217.4035	0	103.4608	0
0.026833	0	26	0	1500000	0	0	0	0	0	3.3E-07	0	359.5003	0	46.94009	0	103.3999	0	0.03404	0	0.04756	0	67.05013	0	8.279003	0	95.1001	0	434.8294	0	217.4034	0	103.4607	0

0.106787	0.08913	26.68768	19.65749	0.23613	3.507906	0.000014
0.127308	0.124348	21.42941	16.00468	1.105807	13.9671	0.000295
0.227428	0.230435	6.796941	7.265517	6.809612	55.54964	0.014061
0.300485	0.317391	3.38186	3.04691	12.48424	83.70269	0.088585
0.343296	0.354348	0.807208	0.765848	16.26946	99.19495	0.53365
0.361256	0.354348	0.061014	0.059224	18.33671	98.1187	6.719657

0.026686	0.019657	0.000236	0.003508	1.4E-06
0.021429	0.016005	0.001106	0.013967	3.0E-07
0.008797	0.007266	0.00681	0.05555	0.000014
0.003382	0.003047	0.012484	0.083703	0.000089
0.000807	0.000766	0.016269	0.099195	0.000534
0.000061	0.000059	0.018337	0.096119	0.00672

nal Membrane Concentrations

mol/m3	Na+ gmol/m3	CO3= gmol/m3	NO3- gmol/m3	H2CO3 gmol/m3	OH- gmol/m3	NaCO3- gmol/m3	NaHCO3 gmol/m3	HCO3- gmol/m3
7.2E-09	321.3825	89.18157	0.394819	0.000024	2.836238	136.6682	0.2594	3.160089
3.6E-08	328.9301	83.98495	14.15071	0.000572	0.56912	131.3177	1.235553	14.92203
3.6E-07	367.2412	50.27129	89.18401	0.034141	0.057924	88.05224	8.025185	89.40514
1.4E-06	399.1255	22.01893	157.0876	0.236115	0.014655	42.27914	15.08316	155.7021
7.2E-06	419.0181	5.543734	200.8097	1.482996	0.002936	11.23591	19.88732	195.8836
0.000093	426.0722	0.426546	230.4926	18.85851	0.000229	0.881866	20.02568	193.845
3.3E-07	359.4971	46.94462	103.4011	0.034041	0.047561	67.05651	8.279028	95.1027
3.3E-07	359.4937	46.94347	103.4019	0.03404	0.047561	67.054	8.279013	95.10258
3.3E-07	359.4927	46.94311	103.4022	0.03404	0.047561	67.05321	8.279009	95.10254
3.3E-07	359.5251	46.95268	103.394	0.034045	0.047559	67.06955	8.279234	95.10866
3.3E-07	359.5082	46.94695	103.3982	0.034042	0.04756	67.05993	8.279111	95.10506
3.3E-07	359.503	46.94517	103.3995	0.034041	0.04756	67.05694	8.279072	95.10395
3.3E-07	359.5904	46.96894	103.3799	0.034055	0.047555	67.09409	8.280036	95.13089
3.3E-07	359.5375	46.95506	103.392	0.034047	0.047558	67.07184	8.27949	95.11601
3.3E-07	359.5224	46.9504	103.3854	0.034045	0.047559	67.06467	8.27932	95.11103

APPENDIX 8

SUPPLEMENTARY INVESTIGATIONS INTO ELECTROMEMBRANE FOULING

This Appendix contains:

Experimental and Analytical Data

Table A8-1
Experimental and Analytical Data for Batch 1

Days	Time (h)	Amp (A)	Temp (°C)	Charge (F)	Volts (V)	Sample	pH	L (mS/cm)	TC (g/l)	IC (g/l)	TOC (g/l)	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	OH (as g/l $CaCO_3$)	CO3 as (g/l $CaCO_3$)	HCO3 (as g/l $CaCO_3$)
1	24	1,2	34	1,07	8,20	anolyte	9,41	27,70	5,13	2,50	2,63	5,00	2,00	9,06	0,0	17,2	3,3
						catholyte			0,76	0,28	0,48	4,00	0,50	53,80	0,0	20,8	87,0
2	48	1,2	34	2,15	9,44	anolyte	8,92	25,20	2,14	1,65	0,49	6,00	2,00	8,21	0,0	5,8	11,6
						catholyte			0,39	0,26	0,13	2,00	0,40	56,86	118,4	8,0	0,0
4	96		35	4,29	11,05	anolyte	8,01	18,60	0,88	0,49	0,39	7,00	2,00	5,74	0,0	2,0	9,4
						catholyte			0,38	0,31	0,07	2,00	0,60	59,58	124,4	9,2	0,0
8	192	1,2	36	8,59	14,40	anolyte	7,87	16,30	5,12	3,93	1,20	5,,0	2,00	5,28	0,0	7,2	3,5
						catholyte				0,27		3,00	1,00	61,88	124,4	6,4	0,0
11	264	1,0	36	11,26	14,51	anolyte	7,89	13,20	2,64	1,89	0,75	7,00	2,00	4,38	0,0	4,8	3,3
						catholyte				0,25		2,00	0,00	62,25	125,2	9,6	0,0
14	336	1,0	36	13,93	18,67	anolyte	9,60	10,70	2,63	1,65	0,97	4,00	2,00	3,05	0,0	4,4	1,3
						catholyte	12,20			0,46		1,00	0,00	65,15	126,0	11,6	0,0
15	360	1,0	37	14,82	20,63	anolyte	9,60	7,92	1,38	0,50	0,87	4,00	2,00	2,58	0,0	1,0	4,1
						catholyte	12,20			0,19		1,00	0,00	64,95	130,2	9,6	0,0
18	432	0,6		16,41	18,58	anolyte	9,20	6,00	1,00	0,23	0,77	2,60	1,90	1,96	0,0	0,8	2,0
						catholyte						2,10	0,10	68,93	123,6	8,4	0,0
21	504					catholyte				0,41		1,50	0,02	66,15	132,6	12,4	0,0

Table A8-2
Experimental and Analytical Data for Batch 2

Days	Time (h)	Amp (A)	Temp (°C)	Charge (F)	Volts (V)	Sample	pH	L (mS/cm)	TC (g/l)	IC (g/l)	TOC (g/l)	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	OH (as g/l $CaCO_3$)	CO3 as (g/l $CaCO_3$)	HCO3 (as g/l $CaCO_3$)
22	528	1,2	34	17,48	9,03	anolyte	9,50	22,60	6,13	3,24	2,89	13,20	6,00	14,39	0,0	17,2	9,7
						catholyte	12,10	436,3	1,25	0,03	1,23	0,90	0,20	59,00	107,0	9,2	0,0
28	672	1,2	35	23,93	12,42	anolyte	8,50	22,30	5,26	2,93	2,33	10,50	4,00	11,49	0,0	6,4	17,0
						catholyte	12,00	487,0				2,60	1,10	57,68	114,2		0,0
31	744	1,2	35	27,14	14,77	anolyte	8,60	23,90				10,30	3,90	9,37	0,0	3,8	15,0
						catholyte	12,20					2,10	1,00	58,78	99,6	13,6	0,0
35	840	1,2	35	31,45	15,04	anolyte	8,33	24,30	4,63	4,00	0,63	11,00	5,50	8,52	0,0	1,6	15,6
						catholyte	13,70					2,50	0,20	62,50	50,4	6,0	0,0
38	912	1,2	36	34,76	20,36	anolyte	8,28	21,50		3,83		9,00	5,20	7,85	0,0	2,6	10,2
						catholyte	13,81					2,30	0,00	68,18	115,8	11,6	0,0
42	1008	0,6	34	37,86	14,41	anolyte	9,80	19,40	3,64	3,35	0,28	9,00	3,30	6,50	0,0	1,0	10,5
						catholyte	12,90					2,00	0,60	64,40	111,2	19,2	0,0
49	1176	0,6	35	41,57	16,02	anolyte	9,80	16,40				8,60	4,00	4,90	0,0	7,4	1,5
						catholyte	12,90					7,60	0,50	70,68	150,0	5,0	0,0
55	1320																
57	1368	0,6	33	45,81	11,20	anolyte	9,80	13,50				8,80	3,90	4,07	0,0	5,8	1,1
						catholyte	12,90					8,00	3,90	3,03			
64	1536	0,6	33	49,52	19,00	anolyte		11,20	1,25	0,83	0,42	8,00	3,90	3,03	0,0	3,6	1,6
						catholyte						3,60	0,90	77,08	155,0	5,0	0,0
67	1608	0,5	33	50,93	19,68	anolyte		8,88	1,64	0,60	1,04	6,60	3,30	2,73	0,0	3,2	1,1
						catholyte						2,50	0,60	80,00	157,5	5,0	0,0

Comments

1) After 55 days a new temperature controller was fitted.

Table A8-3
Experimental and Analytical Data for Batch 3

Days	Time (h)	Amp (A)	Temp (°C)	Charge (F)	Volts (V)	Sample	pH	L (mS/cm)	TC (g/l)	IC (g/l)	TOC (g/l)	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	OH (as g/l $CaCO_3$)	CO3 as (g/l $CaCO_3$)	HCO3 (as g/l $CaCO_3$)
68	1632	1,2	30	52,00	12,20	anolyte	9,5	38,5	7,75	5,38	2,37	12,80	4,30	16,38	0,0	18,0	10,9
						catholyte	13,0	617,5				2,60	0,60	65,10	150,0	5,0	0,0
79	1896	1,2	33	63,80	15,60	anolyte	9,5	33,3	7,25	4,40	2,85	10,50	4,20	12,42	0,0	7,6	16,4
						catholyte	12,9					7,40	1,00	72,30	135,0	5,0	0,0
82	1968	1,2	33	67,04	16,40	anolyte	9,0	32,6	7,13	5,40	1,73	11,30	4,70	12,05	0,0	6,4	16,4
						catholyte	12,8					5,30	1,30	73,50	142,5	5,0	0,0
87	2088	1,0	33	71,49	14,70	anolyte	9,0	29,9	6,39	5,30	1,06	9,70	4,50	10,93	0,0	5,4	15,6
						catholyte	13,0					4,30	0,80	74,20	132,5	5,0	0,0
92	2208	1,0	33	75,94	15,50	anolyte	8,9	28,0	6,00	4,70	1,33	10,40	4,10	9,41	0,0	4,2	14,5
						catholyte	12,9					3,60	1,00	76,25	150,0	5,0	0,0
95	2280	1,0	33	78,61	14,30	anolyte	9,5	26,5	5,01	2,10	2,91	8,60	6,10	8,76	0,0	12,4	5,8
						catholyte	13,3					4,50	0,20	76,15	7,0	0,9	0,0
99	2376	1,0	33	82,17	20,10	anolyte	9,0	24,6	5,25	0,84	4,41	9,20	5,70	7,86	0,0	4,5	13,4
						catholyte	13,8					4,30	0,07	77,73	6,6	1,8	0,0
104	2496	0,6	33	84,82	10,30	anolyte	9,2	24,6	5,13	2,00	3,13	10,20	5,80	8,68	0,0	7,8	12,6
						catholyte	13,2		5,40	2,20	3,20	4,70	2,20	81,33	5,9	1,5	0,0
108	2592	0,6	33	86,94	10,97	anolyte	9,1	22,2	5,26	2,10	3,16	9,50	5,20	5,60	0,0	6,2	10,8
						catholyte	13,3		5,25	2,20	3,05	3,90	2,00	80,90	6,5	1,8	0,0
114	2736	0,6	33	90,12	13,24	anolyte	9,0	20,1	3,15	2,37	0,77	10,00	2,10	7,57	0,0	5,5	6,9
						catholyte	12,5		5,25	0,45	4,80	3,30	0,10	83,88	5,8	1,4	0,0
121	2904	0,6	33	93,83	12,88	anolyte	9,5	18,4	3,10	1,30	1,80	10,30	6,50	6,85	0,0	6,4	6,8
						catholyte	13,5		5,61	0,90	4,70	6,10	1,20	88,93	5,6	1,3	0,0
124	2976	0,6	33	95,42	16,07	anolyte	9,3	17,2	3,50	1,50	2,00	10,60	5,10	5,25	0,0	4,0	5,1
						catholyte	9,5		3,60	1,60	2,00						
129	3096	0,6	33	89,07	17,76	anolyte	9,0	16,5	2,75	0,14	1,35	10,30	4,90	4,59	0,0	2,4	7,4
						catholyte	12,9		5,50	1,10	4,30	4,40	1,10	91,93	7,3	1,4	0,0
135	3240	0,6	33	101,25	21,00	anolyte	9,1	10,7	3,10	0,40	2,60	7,90	4,00	3,88	0,0	1,9	5
						catholyte	12,7		5,70	0,60	5,10	5,40	1,40	89,56			

Table A8-4
Experimental and Analytical Data for Batch 4

Days	Time (h)	Amps (A)	Temp (°C)	Charge (F)	Volts (V)	Sample	pH	L (mS/cm)	Ca (mg/l)	Mg (mg/l)	Na (mg/l)
						anolyte	9,6	32	9,30	3,50	12,02
						catholyte	13,6		3,40	1,40	54,35
1	24	1,2	34	1,07	4,77	anolyte	9,7	32	9,20	3,70	12,10
						cahtolyte	13,7		3,60	1,30	57,60
7	168	1,2	35	7,52	5,30	anolyte	9,8	27,6	9,20	3,40	10,64
						catholyte	13,6		4,00	1,10	60,78
10	240	1,2	35	10,75	5,83	anolyte	9,8	26,5	8,70	3,50	9,20
						catholyte	13,9		3,80	1,00	60,85
13	312	1,2	35	13,97	6,62	anolyte	9,5	24,7	10,80	2,60	9,30
						catholyte	14,0		6,40	1,20	58,50
20	480	1,2	35	21,49	7,46	anolyte	8,8	22,1	8,30	2,90	6,90
						catholyte	13,4		4,40	1,10	62,80
30	720	1,2	35	32,20	13,00	anolyte	9,1	15,0	7,50	2,60	4,43
						catholyte	13,3		4,60	0,90	65,10
35	840	1,2	35	37,60	18,52	anolyte		10,4	6,30	2,00	3,15
						catholyte			5,20	0,70	67,08

Method of Correction of Conductivity for Temperature

During analysis, conductivity data was obtained for the anolyte and catholyte at 25 °C. Using Figure 5.4, the conductivities of the anolyte have been corrected to the experimental temperature of 35 °C.

Conductivity data obtained for the catholyte during analysis at 25 °C is not the same as would be expected if the conductivity was determined theoretically from conductivity charts for sodium hydroxide at 25 °C (Figure 5.5). This discrepancy arises because dilutions were made to the catholyte samples to accomodate the range of measurement of avaliable instrumentation. As the conductivity of sodium hydroxide does not vary proportionally with concentration, analysis of a diluted sample followed by multiplication by the dilution factor introduces error. Therefore, for the catholyte, theoretical conductivities, corrected to the experimental temperature, have been used.

Derivation of Equations to Calculate Membrane Area-Resistance

The area-resistance, R_{mem}, of the membrane can be calculated from the following equation:

$$R_{mem} = \frac{E_{mem}}{CD} \qquad (A8.1)$$

where E_{mem} = volt drop across membrane

CD = current density in A/m^2

The current density is empirically derived, whereas the volt drop across the membrane is determined by the equation:

$$E_{mem} = E_{probes} - E_a - E_c \qquad (A8.2)$$

where E_{probes} = measured volt drop between the platinum probes

E_a = volt drop through the anolyte between the probe and the membrane

E_c = volt drop through the catholyte between the probe and the membrane

E_a and E_c are calculated from basic principles as follows:

The resistance, R, through a volume of electrolyte is given by the equation:

$$R = r\frac{l}{a} \qquad (A8.3)$$

where r = resistivity in units of Wm

l = length of path through electrolyte in m

a = area of path through electrolyte in m^2

and also by the equation:

$$R = \frac{E_{a/c}}{A} \qquad (A8.4)$$

where A = the current flowing in amps

Therefore:

$$Ea/c = r\frac{l}{a}A \tag{A8.5}$$

If the equation for conductivity, *L*, is given by:

$$L = \frac{1}{r} \tag{A8.6}$$

is substituted into equation A8.5, then the volt drop across the electrolyte is given by:

$$E_{a/c} = \frac{1}{L}.l.\frac{A}{a} \tag{A8.7}$$

and is the product of the reciprocal of the electrolyte conductivity; path length (or the distance between the probe and membrane surface) and current density. During the first batch, the membrane was positioned equidistant between both platinum probes; the membrane-probe distance was 0,95 cm. During the course of the following batches, the membrane bulged towards the cathode, and the distance between the cathode probe and membrane was taken as zero, whereas the distance between the anode probe and membrane was taken as 19 mm.

Calculation of Membrane Area-Resistance

Table A8-5
Membrane Area-Resistance for Batch 1

General Parameters			Anolyte				Catholyte				Potential (E) (V)			R_{mem}
Current (A)	Charge (F)	Temperature (°C)	Na (g/l)	L (mS/cm 25°C)	L (mS/cm 35°C)	E_a (V)	Na (g/l)	NaOH (g/l)	L (mS/cm3 5°C)	E_c (V)	probe	$E_c + E_a$	E_{mem} (V)	($\Omega m^2.10^{-3}$)
1,2	1,07	34,0	9,06	27,75	33,0	3,45	53,80	93,56	420,0	2,71	8,20	6,16	2,04	1,70
1,2	2,15	34,0	8,21	25,20	31,0	3,68	56,86	98,88	430,0	2,65	9,44	6,33	3,11	2,60
1,2	4,29	35,0	5,74	18,60	23,3	4,89	59,58	103,6	440,0	2,59	11,05	7,48	3,57	3,00
1,2	8,59	36,0	5,28	16,32	21,8	5,23	61,68	107,6	440,0	2,95	14,40	8,18	6,22	5,20
1,0	11,26	36,0	4,38	13,25	18,2	5,22	62,25	108,3	440,0	2,16	14,54	7,38	7,16	7,16
1,0	13,93	36,0	3,05	10,77	12,8	7,42	65,15	113,3	455,0	2,09	18,67	9,51	9,16	9,16
1,0	14,82	37,0	2,58	7,92	10,8	8,79	64,95	113,0	440,0	2,16	20,63	10,95	9,68	9,68
1,0	16,41	36,0	1,96	6,00	7,4	7,70	68,93	119,8	460,0	1,24	18,58	8,94	9,64	16,10

Table A8-6
Membrane Area-Resistance for Batch 2

General Parameters			Anolyte				Catholyte				Potential (E) (V)			R_{mem}
Current (A)	Charge (F)	Temperature (°C)	Na (g/l)	L (mS/cm 25°C)	L (mS/cm 35°C)	E_a (V)	Na (g/l)	NaOH (g/l)	L (mS/cm3 5°C)	E_c (V)	probe	$E_c +$ E_a	E_{mem} (V)	($\Omega m^2.10^{-3}$)
1,2	1,07	34,0	14,4	22,60	42,7	5,33	59,00	102,6	450,0	0,00	9,03	5,33	3,70	3,00
1,2	7,52	35,0	11,5	22,30	40,3	5,65	57,68	100,3	430,0	0,00	12,42	5,65	6,77	5,60
1,2	10,73	35,0	9,87	23,90	35,2	6,48	58,78	102,2	450,0	0,00	14,77	6,48	8,29	6,90
1,2	15,04	35,0	8,52	24,30	31,8	7,17	62,50	108,7	455,0	0,00	17,59	7,17	10,4	8,70
1,2	18,35	36,0	7,85	21,50	29,8	7,65	68,18	118,6	470,0	0,00	20,36	7,65	12,7	10,60
0,6	21,45	34,0	6,50	19,40	25,4	4,48	64,40	112,0	460,0	0,00	14,41	4,48	9,93	16,50
0,6	25,16	35,0	4,90	16,04	20,0	5,70	70,68	122,9	480,0	0,00	16,02	5,70	10,3	17,20
0,6	29,40	33,0	4,07	13,50	16,8	6,78	73,03	127,0	490,0	0,00	11,20	6,78	4,42	7,36
0,6	33,11	33,0	3,03	11,20	12,7	8,97	77,08	134,1	500,0	0,00	19,00	8,97	10,1	16,80
0,5	34,52	33,0	2,73	8,88	11,6	8,20	80,00	139,1	500,0	0,00	19,68	8,20	11,5	22,90

Table A8-7
Membrane Area-Resistance for Batch 3

General Parameters			Anolyte				Catholyte				Potential (E) (V)			R_{mem}
Current (A)	Charge (F)	Temperature (°C)	Na (g/l)	L (mS/cm 25°C)	L (mS/cm 35°C)	E_a (V)	Na (g/l)	NaOH (g/l)	L (mS/cm3 5°C)	E_c (V)	probe	$E_c +$ E_a	E_{mem} (V)	($\Omega m^2.10^{-3}$)
1,2	52,00	33,0	16,4	38,50	45,0	5,07	65,10	113,2	470,0	0,00	12,20	5,07	7,13	5,90
1,2	63,80	33,0	12,4	33,30	41,6	5,48	72,30	125,7	480,0	0,00	15,60	5,48	10,1	8,40
1,2	67,04	33,0	12,1	32,60	41,0	5,56	73,50	127,8	490,0	0,00	16,40	5,56	10,8	9,00
1,0	71,49	33,0	10,9	29,90	37,5	5,06	74,20	129,0	495,0	0,00	14,70	5,06	9,64	9,60
1,0	75,94	33,0	9,41	28,00	35,6	5,34	76,25	132,6	500,0	0,00	15,50	5,34	10,2	10,20
1,0	78,61	33,0	8,76	26,50	32,5	5,85	76,15	132,4	500,0	0,00	17,00	5,85	11,2	11,15
1,0	82,17	33,0	7,86	24,60	29,6	6,42	77,73	135,2	500,0	0,00	20,10	6,42	13,7	13,68
0,6	84,82	33,0	8,68	24,60	29,6	3,85	80,90	140,7	505,0	0,00	10,30	3,85	6,45	10,85
0,6	86,94	33,0	7,57	22,20	28,7	3,97	83,88	145,9	510,0	0,00	10,97	3,97	7,00	11,70
0,6	90,12	33,0	6,85	20,10	26,4	4,32	81,33	141,4	505,0	0,00	13,24	4,32	8,92	14,86
0,6	93,83	33,0	5,50	18,40	22,3	5,18	88,93	154,7	510,0	0,00	12,88	5,18	7,70	12,80
0,6	95,42	33,0	5,25	17,20	21,5	8,84	-	-	-	0,00	16,07	8,84	7,73	12,00
0,6	98,07	33,0	4,59	16,50	19,2	5,93	91,93	159,9	505,0	0,00	17,76	5,93	11,8	19,72
0,6	101,25	33,0	3,88	10,65	16,5	6,90	89,55	155,7	510,0	0,00	21,00	6,9	14,1	23,50

Table A8-8
Membrane Area-Resistance for Batch 4

General Parameters			Anolyte				Catholyte				Potential (E) (V)			R_{mem}
Current (A)	Charge (F)	Temperature (°C)	Na (g/l)	L (mS/cm 25°C)	L (mS/cm 35°C)	E_a (V)	Na (g/l)	NaOH (g/l)	L (mS/cm3 5°C)	E_c (V)	probe	$E_c +$ E_a	E_{mem} (V)	($\Omega m^2.10^{-3}$)
1,2	0,00	34,0	12,8	32,00	40,0	2,85	54,35	94,5	420,0	0,27	4,77	3,12	1,65	1,33
1,2	1,07	35,0	11,7	32,20	40,0	2,85	57,60	100,2	430,0	0,27	4,77	3,12	1,65	1,33
1,2	7,52	35,0	10,6	27,60	34,5	3,30	60,78	105,7	450,0	0,25	5,30	3,55	1,75	1,46
1,2	10,75	35,0	9,2	26,50	33,5	3,40	60,85	105,8	450,0	0,25	5,83	3,65	2,18	1,82
1,2	13,97	35,0	9,3	24,70	31,5	3,60	61,00	106,0	452,0	0,25	6,62	3,85	2,77	2,31
1,2	21,49	35,0	6,9	22,10	28,2	4,10	62,80	109,2	460,0	0,25	7,46	4,35	3,11	2,60
1,2	32,20	35,0	4,4	14,90	19,0	6,00	65,10	113,2	465,0	0,25	13,0	6,25	6,75	5,63
1,2	37,60	35,0	3,2	10,40	12,8	8,90	69,40	120,7	470,0	0,24	18,5	9,14	9,38	7,82

Calculation of Total Calcium and Magnesium Present in Anolyte

Table A8-9
Total Ca and Mg Present in Anolyte for Duration of Batches 1 to 4

Batch 1					Batch 2					Batch 3					Batch 4				
Days	Charge (F)	Vol (l)	Total Ca (mg)	Total Mg (mg)	Days	Charge (F)	Vol (l)	Total Ca (mg)	Total Mg (mg)	Days	Charge (F)	Vol (l)	Total Ca (mg)	Total Mg (mg)	Days	Charge (F)	Vol (l)	Total Ca (mg)	Total Mg (mg)
1	1,07	40,0	200	80	22	17,48	40,0	520	240	68	52,00	40,0	520	260	135	101,5	40,0	372	140
2	2,15	39,6	238	79	28	23,93	37,8	416	151	79	63,80	36,0	396	230	136	103,0	40,0	368	148
4	4,29	38,7	271	77	31	27,14	36,7	367	147	82	67,04	35,0	385	213	142	108,8	40,0	368	136
8	8,59	37,3	187	75	35	31,45	35,4	389	212	87	71,49	33,4	334	203	145	111,1	36,7	337	136
11	11,26	36,0	252	72	38	34,76	34,0	306	170	92	75,94	31,7	317	218	148	115,3	35,7	386	93
14	13,93	35,4	142	71	42	37,86	32,5	293	130	95	78,61	30,7	276	187	155	122,8	33,4	277	97
15	14,82	35,0	140	70	49	41,57	30,7	264	122	99	82,17	29,4	266	186	166	133,5	30,1	226	78
18	16,41	34,0	102	68	57	45,81	28,0	241	112	108	86,94	26,4	264	177	170	138,9	28,5	180	57
					64	49,52	25,7	206	102	114	90,12	24,4	244	146					
					67	50,93	24,7	173	74	121	93,83	22,0	227	110					
										124	95,42	21,0	231	105					
										129	98,07	19,4	194	95					
										135	101,3	17,3	137	69					

Calculation of Current Efficiencies

Table A8-10
Incremental Current Efficiencies for Sodium Transfer During Batches 1 to 4

Batch	Charge (F)	Anolyte Volume (l)	Total Na (g)	Total Na (moles)	Observed mole change (moles)	Theoretical mole change (moles)	Current Efficiency (%)
1	1,07	40,0	360,0	15,65			
	2,15	39,6	325,0	14,10	1,55	1,08	100
	4,29	38,7	22,0	9,65	4,45	3,22	100
	8,59	37,3	195,0	8,48	7,15	7,52	95
	11,26	36,0	158,0	6,87	8,78	10,19	86
	13,93	35,4	108,0	4,69	10,96	12,86	85
	14,82	35,0	90,0	3,91	11,74	13,75	85
	16,41	34,0	67,0	2,91	12,74	15,34	83
2	17,48	40,0	575,6	25,00			
	23,93	37,8	434,3	18,90	6,10	6,45	95
	27,14	36,7	362,2	15,75	9,25	9,66	96
	31,45	35,4	301,6	13,11	11,89	13,97	85
	34,76	34,0	266,9	11,60	13,40	20,38	66
	37,86	32,5	211,3	9,18	15,80	20,38	78
	41,57	30,7	150,4	6,54	18,46	24,09	77
	45,81	28,0	134,0	5,82	19,18	28,33	68
	49,52	25,7	77,9	3,38	21,62	32,04	67
	50,93	24,7	67,4	2,93	22,07	33,45	66
3	52,00	40,0	655,0	28,47			
	63,80	36,0	477,1	19,44	9,03	11,80	77
	67,04	35,0	422,0	18,34	10,13	15,04	67
	71,49	33,4	365,0	15,87	12,60	19,49	65
	75,94	31,7	298,0	12,96	15,51	23,94	65
	78,61	30,7	269,0	11,69	16,78	26,61	63
	82,17	29,4	231,0	10,00	18,47	30,17	61
	86,94	26,4	199,8	8,68	19,79	34,94	57
	90,12	24,4	167,1	7,26	21,21	38,12	56
	93,83	22,0	121,0	5,26	23,21	41,81	55
	95,42	21,0	110,3	4,79	23,68	43,42	55
	98,07	19,4	89,0	3,87	24,60	46,07	53
	101,3	17,3	67,1	2,92	25,55	49,25	52
4	101,5	40,0	512,0	22,30			
	103,0	40,0	484,0	21,00	1,30	1,07	100
	111,1	36,7	337,6	14,60	7,70	10,75	72
	115,3	35,7	332,0	14,40	7,90	13,97	57
	122,8	33,4	230,5	10,00	12,30	21,45	57
	133,5	30,1	133,3	5,80	16,50	32,20	51
	138,9	28,5	90,2	3,90	18,40	37,60	49

APPENDIX 9

SUPPLEMENTARY INVESTIGATIONS INTO ELECTROMEMBRANE CLEANING

This Appendix contains:

Analytical and Physical Data for Electromembrane Cleaning Programmes

Table A9-1
Experiment 2.1 - Acid Electrolysis

Acid wash solution	nitric acid, pH 1,5
Current	0,5 A for 21 hours
Initial volumes	800 ml
Final anolyte volume	650 ml
Final catholyte volume	500 ml
Total exposed membrane area	0,0081 m^2

Determinand	Initial Acid	Final Anolyte	Final Catholyte
pH	2,1	2,6	12,2
Ca (mg/l)	7,0	7,0	580,0*
Mg (mg/l)	3,0	1,0	61,0*

*Analysis performed after acidification to pH 1,4 with H_2SO_4

<u>Observations</u>

1) Thick white precipitate, identified as $CaCO_3$, present in suspended form in catholyte after cleaning.
2) Anolyte still clear.
3) Most of electromembrane surface was visibly free from scale after cleaning.

The procedure was repeated using nitric acid, again at pH 1,5, but at a current of 2 A. A black precipitate, which was not identified, formed in the catholyte.

Table A9-2
Experiment 2.3 - Rate of Descaling by Acid Electrolysis

Acid wash solution	nitric acid, pH 1,8
Current	0,4 A for 8,8 hours
Initial volumes	825 ml
Final anolyte volume	720 ml
Final catholyte volume	720 ml
Total exposed membrane area	0,0081 m^2

Sample	Time (h-min)	Faradays (F)	Potential (V)	Temperature (°C)	Volume (ml)	pH	Ca (mg/l)	Mg (mg/l)
anolyte	0-00	0	3,0	16	825	1,8	8	3
catholyte					825			
anolyte	0-40	0,01	2,6	17	815	1,6	171	27
catholyte					830	1,6	151	100
anolyte	1-25	0,02	2,7	17	795	1,6	200	29
catholye					805	1,6	281	141
anolyte	2-30	0,06	2,8	17	775	1,6	199	29
catholyte					785	1,6	356	151
anolyte	3-50	0,04	2,8	18	765	1,6	180	28
catholyte					775	1,6	403	152
anolyte	5-10	0,08	2,8	18	735	1,6	169	28
catholyte					745	1,6	418	160
anolyte	6-50	0,1	2,8	19	730	1,6	151	28
catholyte					740	1,6	442	156
anolyte	9-15	0,14	2,9	19	720	1,6	156	29
catholyte					720	1,6	462	160

Observations

1) During this cleaning procedure there was a leak from the cell - a total of approximately 80 ml leaked out from both compartments at a rate of approximately 10 ml/hour.
2) During this clean 70 ml of electrolyte was removed from each compartment as samples. Taking intermittent concentrations and leaks into account, this amounts to the removal of 56 mg Ca and 20 mg from the system.

Table A9-3
Experiment 3.1 - Acid Soaking

Acid soaking solution	2 000 ml nitric acid (pH 1,5) in stirred beaker
Time	3 days
Total exposed membrane area	0,015 m^2

Determinand	Initial Acid	Final Acid
pH	1,5	1,5
Ca (mg/l)	7,0	407,0
Mg (mg/l)	3,0	132,0

Observations

1)The electromembrane surface appeared visibly free from scale after soaking.

Table A9-4
Experiment 3.3 - Acid Soaking

Acid soaking solution	2 000 ml nitric acid (pH 0,5) in stirred beaker
Time	3 days
Total exposed membrane area	0,015 m^2

Determinand	Initial Acid	Final Acid
pH	0,5	0,6
Ca (mg/l)	10,0	485,0
Mg (mg/l)	3,0	158,0

Observations

1)The electromemrane surface appeared free from scale after soaking.

Table A9-5
Experiment 3.5 - Rate of Descaling by Acid Soaking

Descaling soaking solution	nitric acid, pH 1,3
Volume	600 ml
Initial membrane mass	2,51 g
Final membrane mass	1,66 g
Sample volumes	10 ml
Total scaled membrane area	0,0033 m^2

Time (h-min)	pH	Ca (mg/l)	Mg (mg/l)	Volume (ml)
0-00	1,1	10	3,3	600
1-00	1,3	201	45,0	600
2-35	1,4	301	68,0	590
4-05	1,5	396	85,0	580
6-15	1,6	400	84,0	570
8-05	1,7	431	86,0	560
12-05	1,7	452	86,0	550
23-40	1,7	446	85,0	540
35-35	1,7	452	87,0	530
47-05	1,7	462	87,0	520

Observations

1) During this clean 90 ml of nitric acid was removed as samples. Taking intermittent concentrations into account, this amounts to the total removal of 35 mg and 7 mg Mg.

Table A9-6
Experiment 4.1 - Acid Electrolysis of Acid Soaked Electromembrane

After experiment 3.2, the same sample of membrane was electrolytically cleaned.

Acid wash solution	nitric acid, pH 2
Current	0,5 A
Initial volumes	800 ml
Final anolyte volume	700 ml
Final catholyte volume	600 ml
Total exposed membrane area	0,0081 m^2

Determinand	Initial Acid	Final Anolyte	Final Catholyte
pH	2,0	2,9	7,9
Ca (mg/l)	7,0	2,0	88,0
Mg (mg/l)	3,0	0,2	9,0

Observations
1) The catholyte contained a dark precipitate.
2) The anolyte was clear.

Table A9-7
Experiment 4.3 - Rate of Descaling by Acid Electrolysis of Acid Soaked Electromembrane

After experiment 3.4, the electromembrane was mounted in the cell and soaked overnight in nitric acid (pH 1) with no agitation, before electrolysis was commenced.

Acid wash solution	nitric acid, pH 1
Current	0,5 A
Initial volumes	800 ml
Final anolyte volume	740 ml
Final catholyte volume	750 ml
Total exposed membrane area	0,0081 m^2

Sample	Time (h-min)	Faradays (F)	Potential (V)	Temperature (°C)	Volume (ml)	pH	Ca (mg/l)	Mg (mg/l)
initial acid	0-00	-		ambient	800 x 2	1,0	10,5	3,3
after soaking:								
anolyte	16-00	0,00	3,3	20	800	1,1	22,6	5,1
catholyte					800	1,1	22,2	4,7
electrolysis:								
anolyte	0-40	0,01	3,6	20	785	1,1	19,7	4,3
catholyte					790	1,1	38,2	6,8
anolyte	2-10	0,04	3,6	20	770	1,0	11,2	2,7
catholyte					775	1,2	53,0	8,2
anolyte	4-05	0,08	3,7	22	755	1,1	7,2	1,8
catholyte					760	1,2	63,5	9,1
anolyte	6-40	0,12	4,1	23	740	1,1	5,7	1,0
catholyte					750	1,5	70,0	9,7

Observations
1) During this clean 30 ml of nitric acid was removed as samples from each compartment. Taking intermittent concentrations into account, this amounts to a total removal of 26 mg Ca and 6 mg Mg.

Analytical and Physical Data for Reference Run and Performance Tests

Cell parameters

number of compartments	2
width	98 mm
height	95 mm
length	100 mm
anode-cathode distance	23 mm
exposed electromembrane area	0,0081 m^2
volume of electrolytes (each)	800 ml
anolyte	50 g/l sodium bicarbonate
catholyte	100 g/l sodium hydroxide
current (unless otherwise stated)	2,5 A

Voltage recorded

Voltage was measured across the electrodes and represents the combined volt drop through the anode, anolyte (11,5 mm), electromembrane, catholyte (11,5 mm) and cathode.

Volume

Volume was calculated by measuring the change in height of the electrolyte during electrolysis - 1 mm is equivalent to 9 ml. The volumes of samples extracted (15 ml) were considered.

Table A9-8
Experiment 1.1 - Reference Run on Scaled Electromembrane

							Sample Analysis								
Sample	Time (h)	CD (A/m^2)	Charge (F)	Volts (V)	Temp (°C)	Volume (l)	pH	L (mS/cm)	OH^- (g/l)	$CO_3^=$ (g/l)	HCO_3^- (g/l)	Total CO_2 (g/l)	Na (g/l)	Ca (mg/l)	Mg (mg/l)
anolyte	0,00	310	0,00	5,4	24	800	8,6	33	0,0	9,6	18,8	20,7	13,6	7,8	1,0
catholyte						800			37,7	3,6		2,6	62,5	7,6	0,2
anolyte	1,15	310	0,12	10,6	30	770	8,9	34	0,0	8,3	20,1	20,8	14,4	5,8	2,6
catholyte						780			37,4	3,0		2,0	61,5	9,4	0,4
anolyte	3,10	310	0,30	10,9	32	745	9,1	37	0,0	8,2	24,9	24,2	16,7	6,7	3,4
catholyte						790			37,6	3,6		2,6	55,4	12,3	0,4
anolyte	5,15	310	0,49	11,0	33	710	9,3	39	0,0	10,3	22,4	23,9	17,2	6,3	2,9
catholyte						765			38,8	3,0		2,0	60,6	9,2	0,4

Table A9-9
Experiment 2.2 - Performance Test on Acid Electrolysed Membrane (from Exp. 2.1)

							Sample Analysis						
Sample	Time (h)	CD (A/m^2)	Charge (F)	Volts (V)	Temp (°C)	Volume (l)	pH	L (mS/cm)	OH^- (g/l)	$CO_3^=$ (g/l)	HCO_3^- (g/l)	Total CO_2 (g/l)	Na (g/l)
anolyte	0,00	310	0,0	11,0	23	800	9,0	38	0,0	9,6	18,8	20,7	15,4
catholyte						800			37,7	3,6		2,6	59,5
anolyte	1,45	310	0,2	9,9	27	760	8,6	35	0,0	9,0	16,3	18,5	14,9
catholyte						810			39,1				63,1
anolyte	3,40	310	0,3	6,0	28	710	8,7	29	0,0	8,2	12,4	15,0	12,3
catholyte						800			43,4	4,5		3,3	64,6
anolyte	5,40	310	0,5	6,5	28	680	8,5	24	0,0	3,6	14,0	12,8	9,6
catholyte						790			44,2	4,5		3,3	68,1

Table A9-10
Experiment 2.2 - Performance Test on Acid Electrolysed Membrane (from Exp. 2.3)

Sample	Time	CD	Charge	Volts	Temp	Volume	Sample Analysis						
							pH	L (mS/cm)	OH^-	$CO_3^=$	HCO_3^-	Total CO_2	Na
	(h)	(A/m^2)	(F)	(V)	(°C)	(l)			(g/l)	(g/l)	(g/l)	(g/l)	(g/l)
anolyte	0,00	310	0,00	5,5	20	800	8,5	36	0,0	3,3	29,3	23,8	15,9
catholyte						800			43,7	3,0	0,0	2,2	63,9
anolyte	2,00	310	0,17	5,5	22	760	8,1	26	0,0	2,9	21,3	17,7	12,3
catholyte						820			43,7	2,4	0,0	1,8	64,8
anolyte	4,00	310	0,34	6,2	23	720	8,4	23	0,0	2,9	13,8	12,2	8,3
catholyte						800			45,7	3,0	0,0	2,4	65,7
anolyte	6,00	310	0,51	7,6	25	680	8,6	13	0,0	2,1	6,4	6,2	4,9
catholyte						810			46,1	3,0	0,0	2,4	68,7

Observations

During this experiment there was a leak of approximately 200 ml/h of electrolyte from both compartments. This electrolyte was collected and returned to the catholyte compartment. The effect was that the catholyte was diluted by 10 ml/h of anolyte, with an equivalent loss of 10 ml/h from the anolyte compartment.

Table A9-11
Experiment 3.2 - Performance Test on Acid Soaked Membrane (from Exp. 3.1)

Sample	Time	CD	Charge	Volts	Temp	Volume	Sample Analysis						
							pH	L (mS/cm)	OH^-	$CO_3^=$	HCO_3^-	Total CO_2	Na
	(h)	(A/m^2)	(F)	(V)	(°C)	(l)			(g/l)	(g/l)	(g/l)	(g/l)	(g/l)
anolyte	0,00	310	0,00	10,6	29	800,0	9,1	36	0,0	7,3	21,6	21,1	15,6
catholyte						800,0			39,1	3,6		2,6	61,8
anolyte	3,10	310	0,29	10,4	31	730,0	9,3	26	0,0	8,2	8,5	12,2	11,6
catholyte						800,0			42,3	4,2		3,1	65,1
anolyte	6,20	310	0,62	12,3	31	665,0	9,5	12	0,0	2,9	3,9	5,0	4,8
catholyte						805,0			47,3	2,4		1,8	73,8

Table A9-12
Experiment 3.4 - Performance Test on Acid Soaked Membrane (from Exp. 3.3)

Sample	Time	CD	Charge	Volts	Temp	Volume	Sample Analysis						
							pH	L (mS/cm)	OH^-	$CO_3^=$	HCO_3^-	Total CO_2	Na
	(h)	(A/m^2)	(F)	(V)	(°C)	(l)			(g/l)	(g/l)	(g/l)	(g/l)	(g/l)
anolyte	0,00	310	0,00	5,7	19	800,0	8,8	38	0,0	5,6	34,4	29,2	16,7
catholyte						800,-0			47,9	1,5	0,0	1,1	61,3
anolyte	1,50	310	0,17	5,0	24	770,0	8,7	29	0,0	3,1	26,4	21,5	12,6
catholyte						780,0			50,3	2,4	0,0	1,8	62,3
anolyte	3,50	310	0,36	5,5	26	720,0	8,8	20	0,0	2,9	13,4	11,9	6,6
catholyte						770,0			54,6	3,0	0,0	2,2	71,8
anolyte	5,35	310	0,52	7,0	28	700,0	8,0	9	0,0	0,8	6,8	5,5	3,3
catholyte						770,0			57,1	2,4	0,0	1,8	74,2

Table A9-13
Experiment 2.2 - Performance Test on Acid Soaked & Electrolysed Membrane (from Exp. 4.1)

Sample	Time (h)	CD (A/m^2)	Charge (F)	Volts (V)	Temp (°C)	Volume (l)	Sample Analysis pH	L (mS/cm)	OH^- (g/l)	$CO_3^=$ (g/l)	HCO_3^- (g/l)	Total CO_2 (g/l)	Na (g/l)
anolyte	0,00	62	0,00	7,0	22	800,0	9,1	36	0,0	7,3	21,6	21,1	15,6
catholyte						800,0			39,1	3,6		2,6	61,8
anolyte	2,20	62	0,04	7,1	25								
anolyte		310	0,04	12,4									
anolyte	3,45	310	0,17	10,7	27	790,0	9,2	36	0,0	8,3	18,0	17,1	14,1
catholyte						800,0			44,0	3,0		2,2	63,5
anolyte	7,45	310	0,54	10,9	31	725,0	8,9	26	0,0	8,3	9,1	12,7	9,7
catholyte						870,0			44,4	3,6		2,6	65,9

Observations

The current was initially set at 0,5 A, but was raised to 2,5 A after 2,2 h.

Table A9-14
Experiment 4.4 - Performance Test on Acid Soaked & Electrolysed Membrane (from Exp. 4.3)

Sample	Time (h)	CD (A/m^2)	Charge (F)	Volts (V)	Temp (°C)	Volume (l)	Sample Analysis OH^- (g/l)	$CO_3^=$ (g/l)	HCO_3^- (g/l)	Total CO_2 (g/l)	Na (g/l)
anolyte	0,00	310	0,00	5,8	19,5	800,0	0,0	12,7	10,5	16,9	16,6
catholyte						800,0	41,8	5,4	0,0	3,9	57,6
anolyte	1,40	310	0,15	5,7	22,0	780,0	0,0	7,1	14,9	16,0	13,5
catholyte						790,0	44,5	6,0	0,0	4,4	60,6
anolyte	4,10	310	0,39	6,3	24,0	740,0	0,0	3,8	12,2	11,7	9,3
catholyte						780,0	44,2	4,8	0,0	3,5	65,5
anolyte	6,00	310	0,56	7,3	25,0	700,0	0,0	3,6	4,6	6,0	5,6
catholyte						780,0	51,0	4,8	0,0	3,5	66,6

Calculations of Current Efficiencies (CE)

Table A9-15
Experiment 1 - Reference Run Using Scaled Membrane

Sample	Charge (F)	Theoretical Change (mol)	Na Species: Total (g)	Na Species: Obs. change (mol)	Na Species: CE (%)	Carbonate/Bicarbonate Species: Total CO_3 (g)	Total CO_2 (g)	Obs. change CO_3 (mol)	Obs. change CO_2 (mol)	Total change (mol)	CE (%)	OH Species: Total (g)	OH Species: Obs. change (mol)	OH Species: CE (%)
anolyte	0,00	0,00	10,9			7,7	16,6					30,2		
catholyte			50,0											
anolyte	0,12	0,12	11,0		0	6,4	16,0	0,02	0,01	0,03	25			
catholyte			48,0		0							29,2		0,0
anolyte	0,30	0,30	12,4		0	6,1	18,0				0			
catholyte			43,8		0							29,7		0,0
anolyte	0,49	0,49	12,2		0	7,3	17,0	0,01	0,01	0,02	4			
catholyte			46,4		0							29,7		0,0

Table A9-16
Experiment 1.2 - Reference Run on Virgin Electromembrane

Faradays (F)	Theoretical change (g)	Anolyte Na loss (g)	Anolyte Volume (ml)	Catholyte Na gain (g)	Catholyte Volume (ml)
0,00	-	-	750	-	750
0,12	2,8	2,4		0,5	
0,26	6,0	3,8		-	
0,41	9,4	6,2		6,6	
0,51	11,7	7,7		5,5	
0,73	16,8	11,7		10,8	
0,87	20,0	13,9		-	
0,92	21,2	14,8	675	14,1	775

Using volume and Na loss/gain figures, loss of Na from the anolyte was calculated to be 16,2 g, while gain in the catholyte is 16,1 g. These figures represent current efficiencies of 76 %.

Table A9-17
Experiment 2.2 - Performance Test on Acid Electrolysed Membrane (from Exp. 2.1)

Sample	Charge (F)	Theoretical Change (mol)	Na Species: Total (g)	Na Species: Obs. change (mol)	Na Species: CE (%)	Carbonate/Bicarbonate Species: Total CO_3 (g)	Total CO_2 (g)	Obs. change CO_3 (mol)	Obs. change CO_2 (mol)	Total change (mol)	CE (%)	OH Species: Total (g)	OH Species: Obs. change (mol)	OH Species: CE (%)
anolyte	0,00	0,00	12,3			7,7	16,6							
catholyte			47,6									30,2		
anolyte	0,16	0,16	11,2	0,05	30	6,8	14,1	0,02	0,06	0,08	50			
catholyte			51,1	0,15	95							31,7	0,09	55,0
anolyte	0,34	0,34	8,9	0,15	43	5,9	11,0	0,03	0,13	0,16	46			
catholyte			52,6	0,22	64							35,3	0,27	77,0
anolyte	0,53	0,53	6,9	0,24	47	2,6	9,2	0,09	0,17	0,26	49			
catholyte			55,7	0,35	66							36,2	0,35	67,0

Table A9-18
Experiment 2.4 - Performance Test on Acid Electrolysed Membrane (from Exp. 2.3)

			Na Species			Carbonate/Bicarbonate Species						OH Species		
Sample	Charge (F)	Theoretical Change (mol)	Total (g)	Obs. change (mol)	CE (%)	Total CO_3 (g)	Total CO_2 (g)	Obs. change CO_3 (mol)	Obs. change CO_2 (mol)	Total change (mol)	CE (%)	Total (g)	Obs. change (mol)	CE (%)
anolyte	0,00	0,00	12,7			2,6	19,0							
catholyte			51,1									35,0		
anolyte	0,17	0,17	9,6	0,13	76	2,3	13,9	0,00	0,12	0,12	71			
catholyte			52,8	0,08	47							35,4	0,02	14,0
anolyte	0,34	0,34	6,7	0,26	76	2,2	9,7	0,01	0,22	0,22	65			
catholyte			53,1	0,09	26							37,1	0,12	36,0
anolyte	0,51	0,51	4,2	0,37	72	1,3	5,5	0,02	0,33	0,33	65			
catholyte			57,0	0,26	51							38,4	0,20	39,0

Note that losses resulting from leak have been taken into account

Table A9-19
Experiment 3.2 - Performance Test on Acid Soaked Membrane (from Exp. 3.1)

			Na Species			Carbonate/Bicarbonate Species						OH Species		
Sample	Charge (F)	Theoretical Change (mol)	Total (g)	Obs. change (mol)	CE (%)	Total CO_3 (g)	Total CO_2 (g)	Obs. change CO_3 (mol)	Obs. change CO_2 (mol)	Total change (mol)	CE (%)	Total (g)	Obs. change (mol)	CE (%)
anolyte	0,00		12,5			5,8	16,9							
catholyte			49,4									31,3		
anolyte	0,29	0,29	8,5	0,17	60	6,0	8,9		0,18	0,18	63			
catholyte			52,1	0,12	41					65,10		33,8	0,15	51,0
anolyte	0,62	0,62	3,4	0,40	65	2,0	3,5	0,06	0,30	0,36	58			
catholyte			60,4	0,44	70							38,7	0,40	64,0

Table A9-20

Experiment 3.4 - Performance Test on Acid Soaked Membrane (from Exp. 3.3)

Sample	Charge (F)	Theoretical Change (mol)	Na Species Total (g)	Na Species Obs. change (mol)	Na Species CE (%)	Carbonate/Bicarbonate Species Total CO_3 (g)	Total CO_2 (g)	Obs. change CO_3 (mol)	Obs. change CO_2 (mol)	Total change (mol)	CE (%)	OH Species Total (g)	OH Species Obs. change (mol)	OH Species CE (%)
anolyte	0,00	0,00	13,4			4,5	23,4							
catholyte			49,0									38,3		
anolyte	0,17	0,17	9,7	0,16	95	2,4	16,6	0,04	0,15	0,19	100			
catholyte			48,6									39,2	0,05	32,0
anolyte	0,36	0,36	5,0	0,36	100	2,1	8,5	0,04	0,34	0,38	100			
catholyte			56,2	0,31	87							42,8	0,26	74,0
anolyte	0,52	0,52	2,6	0,47	90	0,6	4,4	0,07	0,43	0,50	96			
catholyte			59,1	0,44	84							45,6	0,43	83,0

Table A9-21

Experiment 4.2 - Performance Test on Acid Soaked & Electrolysed Membrane (from Exp. 4.1)

Sample	Charge (F)	Theoretical Change (mol)	Na Species Total (g)	Na Species Obs. change (mol)	Na Species CE (%)	Carbonate/Bicarbonate Species Total CO_3 (g)	Total CO_2 (g)	Obs. change CO_3 (mol)	Obs. change CO_2 (mol)	Total change (mol)	CE (%)	OH Species Total (g)	OH Species Obs. change (mol)	OH Species CE (%)
anolyte	0,00	0,00	12,5			5,8	16,9							
catholyte			49,4									31,3		
anolyte	0,17	0,17	11,1	0,06	36	6,6	13,5		0,08	0,08	45			
catholyte			50,8	0,06	36							35,2	0,23	
anolyte	0,54	0,54	7,2	0,23	44	6,0	9,2		0,18	0,18	32			
catholyte			53,7	0,15	28							36,2	0,25	46,0

Table A9-22
Experiment 4.4- Performance Test on Acid Soaked & Electrolysed Membrane (from Exp. 4.3)

Sample	Charge (F)	Theoretical Change (mol)	Na Species: Total (g)	Na Species: Obs. change (mol)	Na Species: CE (%)	Carbonate/Bicarbonate Species: Total CO_3 (g)	Total CO_2 (g)	Obs. change CO_3 (mol)	Obs. change CO_2 (mol)	Total change (mol)	CE (%)	OH Species: Total (g)	Obs. change (mol)	CE (%)
anolyte	0,00	0,00	13,3			10,2	13,5							
catholyte			46,1									33,4		
anolyte	0,15	0,15	10,5	0,12	80	5,5	11,6	0,08	0,04	0,12	80			
catholyte			47,9	0,08	53							35,2	0,11	73,0
anolyte	0,39	0,39	7,1	0,27	69	2,9	8,9	0,12	0,10	0,22	57			
catholyte			52,0	0,26	67							35,2	0,11	28,0
anolyte	0,56	0,56	4,2	0,40	71	2,6	4,6	0,13	0,20	0,33	60			
catholyte			53,8	0,33	60							41,2	0,45	82,0

Calculations of Rate of Scale Removal During Cleaning

Note that total Ca/Mg removed has been calculated as the difference between the sum of the amount in the anolyte, amount in catholyte, and amount in the samples; and the amount initially present in the electrolytes.

Table A9-23
Experiment 2.3 - Acid Electrolysis

Time (h)	Ca in anolyte (mg)	Ca in catholyte (mg)	Ca in samples (mg)	Total Ca removed (mg)	Total Ca removed (mg/cm^2)	Mg in anolyte (mg)	Mg in catholyte (mg)	Mg in samples (mg)	Total Mg removed (mg)	Total Mg removed (mg/cm^2)
0	7	-	7	-	-	2	-	2	-	-
0,67	139	125	0	243	3,0	22	83	0	99	1,2
1,42	159	226	4	375	4,6	23	114	2	134	1,7
2,50	154	279	11	430	5,3	22	119	4	141	1,7
3,82	138	312	21	457	5,6	21	118	7	142	1,8
5,18	124	311	33	454	5,6	21	119	11	147	1,8
6,82	110	327	42	465	5,7	20	115	14	145	1,8
9,25	112	333	55	486	6,0	21	115	20	152	1,9

Table A9-24
Experiment 3.5 - Acid Soaking

Time (h)	Ca in solution (mg)	Ca in samples (mg)	Total Ca removed (mg)	Total Ca removed (mg/cm^2)	Mg in solution (mg)	Mg in samples (mg)	Total Mg removed (mg)	Total Mg removed (mg/cm^2)
0,00	6	0	-	-	2	0,0	-	-
1,00	121	0	115	3,5	27	0,0	25	0,8
2,58	178	2	174	5,3	40	0,5	39	1,2
4,08	230	5	229	6,9	49	1,2	48	1,5
6,25	228	9	231	7,0	48	2,0	48	1,5
8,08	241	13	248	7,5	48	2,9	49	1,5
12,08	249	17	260	7,9	47	3,8	49	1,5
23,67	241	22	257	7,8	46	4,6	49	1,5
35,58	240	26	260	7,9	46	5,5	50	1,5
47,08	240	30	264	8,0	45	6,4	49	1,5

Table A9-25
Experiment 4.3 - Acid Soaking and Electrolysis

Time (h)	Ca in anolyte (mg)	Ca in catholyte (mg)	Ca in samples (mg)	Total Ca removed (mg)	Total Ca removed (mg/cm^2)	Mg in anolyte (mg)	Mg in catholyte (mg)	Mg in samples (mg)	Total Mg removed (mg)	Total Mg removed (mg/cm^2)
0	8,0	8	-	-	-	2,6	2,6	-	-	-
12	18,0	18	-	20	0,25	4,1	3,8	-	2,7	0,03
-	18,0	18	-	-	-	4,1	3,8	-	-	0,01
-	15,5	30	0,4	10	0,12	3,4	5,4	0,1	1,0	0,01
-	8,6	41	1,0	15	0,19	2,1	6,4	0,2	0,8	0,01
-	5,4	48	1,6	19	0,23	1,4	6,9	0,4	0,9	0,01
-	4,2	53	2,3	24	0,30	0,7	7,3	0,5	0,6	0,01

APPENDIX 10

SUPPLEMENTARY INVESTIGATIONS INTO OTHER ANODE MATERIALS

This Appendix contains:

Experimental Data for Pilot Plant

Page A10-2 to A10-8

Experimental Data for Laboratory Tests

Pages A10-9 to A10-10

Experimental Data for Pilot Plant

Table A10-1
Physical and Analytical Data for Stainless Steel Anodes (Pilot Plant Exp. 17B)

Anolyte	13 litres of 50 g/l $NaHCO_3$
Catholyte	20 litres NaOH
Absorption column	38 litres partially carbonated effluent

Time (h)	CD (A/m^2)	F	Overall (V)	anode-mem. (V)	Temp (°C)	Vol. (l)	Sample	pH	L (mS/cm)	OH (g/l)	CO_3 (g/l)	HCO_3 (g/l)	Total CO_2 (g/l)	Na (g/l)	Fe (g/l)
0-00	60	0,0	2,4		48	13,3	anolyte	8,5	34	0,0	4,3	24,6	21,1	13,2	0
	280		3,0			20,0	catholyte	13,0	33	28,9	3,0	0,0	2,2	43,5	
	600		3,7												
	1100		4,9												
	1400		5,5												
0-25	1400	1,2	5,5	2,3	50										
0-45	1400	2,1	5,9	2,8	51										
1-05	1400	2,7	6,2	3,1	52		anolyte	8,5	29	0,0	2,2	20,9	16,9	9,4	6
1-30	1400	4,0	6,4	2,9	53										
1-45	1400	4,5	5,8	3,0	53	12,5	anolyte	8,1	26	0,0	1,7	17,4	13,9	8,7	2
						20,5									

Comments
1) After 2,7 F the anolyte turned yellow.
2) After 4,5 F, the experiment was stopped becasue of a brown precipitate in the anolyte.
3) The precipitate from the anolyte samples at 2,7 and 4,5 F was filtered and redissolved in acid. AA analyses indicated high levels of iron.
4) Currrent efficiencies for sodium loss from anolyte were 65 %, and for CO_2 loss from the anolyte were 54 %.

Table A10-2
Physical and Analytical Data for Nickel Anodes (Pilot Plant Exp. 19B)

Anolyte	20 litres of nanofiltrate from exp. 19
Catholyte	15 litres 10 % NaOH
Absorption column	60 litres effluent + 50 g/l $NaHCO_3$

Time (h)	CD (A/m^2)	F	over-all (V)	cell (V)	mem. (V)	cath. - mem. (V)	anode-mem. (V)	Temp (°C)	Vol. (l)	Sample	pH	L (mS/cm)	OH (g/l)	CO_3 (g/l)	HCO_3 (g/l)	Total CO_2 (g/l)	Na (g/l)	Ni (g/l)
0-00	20	0,0	2,0					23	20,0	anol.	8,1	96	0,0	4,7	8,8	9,9	36,9	0
	200		2,6						15,0	cathol.	14,0	17	29,8	9,0	0,0	6,6	49,2	
	400		3,0						60,0	column	9,1	44	0,0	15,1	15,6	22,4	21,8	
	1000		3,8															
	1600		4,6															
	2000		5,1	4,3	0,10	1,60	2,60											
	3000		6,2															
	3600		6,9															
	4000		7,8															
	5000		8,4															
	6000		9,6															
	7000		10,8															
3,06	40	11,1	2,0					50	20,0	anol.	6,9	91	0,0	1,4	8,5	5,8	31,6	
	1000		3,5						15,0	cathol.		22	34,0	9,0	0,0	6,6	50,9	
	2000		4,8	4,4	0,10	1,70	2,80		60,0	column	9,4	45	0,0	16,2	13,4	21,6		
	3000		6,2															
	4000		8,2															
	5000		11,1															
	6000		12,9															
4,06	2000	16,1	4,7	4,2				55										
4,25	0	16,1	2,3															
	200		2,2															
	800		4,3															
	1600		5,9															
	2000		6,6	4,1	0,20	1,00	3,00	21										
5,15	2000	12,2	12,1	10,2	0,10			38	19,7	anol.	6,2	62	0,0	0,0	4,0	2,9	18,6	86
									15,5	cathol.		16	24,7	3,0	0,0	1,6	44,1	
									60,0	column	9,1	45	0,0	12,7	18,5	22,8		
5,45																		
6,00	2000	21,0	5,0															
6,25		21,4																
6,25	20	21,4	2,1					24										
	400		3,1															
	1000		4,4															
	1800		5,7															
	2000		6,0	2,8	0,10	2,00	2,10											
8,15	400		2,7	0,6				48		anol.								
	1000		3,6	1,0														
	1600		4,5	1,1														
	2000		5,2	1,3														
	2400		5,7	1,2														
	3000		6,7	1,3														
	4000		8,7	1,9														
	5000		11,1	2,5														
9,10	2000	31,8	7,0					51	18,6	anol.	6,7	70	0,0	0,0	12,2	8,9	23,8	347
									16,1	cathol.		15	24,0	3,0	0,0	1,8	39,0	
									60,0	column	9,2	45	0,0	13,4	19,6	24,1		
10,40	2000	37,9	4,8	0,8	0,06	0,20	0,40	45										
11,40	400	41,6	2,6	0,2				55	18,2	anol.	7,9	97	0,0	11,2	52,1	46,2	37,9	406
	1000		3,4	0,5					17,0	cathol.		17	25,5	3,0	0,0	1,8	44,9	
	1600		4,2	0,6	0,07	1,20	0,30		60,0	column	8,9	45	0,00	7,1	30,8	27,5		
	2400		5,2	2,1														
	3000		5,9	1,9														
	4000		6,5	2,3														
	5000		7,7	6,4														
	6000		8,9	7,4														
	7000		10,6	9,7														
12,50	1600	45,7	4,0	3,6	0,08	1,70	1,80	48	17,3	anol.	7,7							
									7,0	cathol.								
									60,0	column								

Comments

1) After 0,0 F continued to run at 2 000 A/m^2.
2) After 11,1 F the anolyte contained a pale green precipitate.
3) After 16,1 F the catholyte tank was leaking and the experiment was stopped. The cell was dismantled and, on inspection, the nickel anode was found to be covered in a black deposit.
4) After 19,2 F the anolyte had turned black and contained a grey precipitate. 1 kg of $NaHCO_3$ was added to the anolyte (11,9 moles $NaHCO_3$).
5) After 21,4 F a ball valve on the catholyte side had become deformed with heat and needed replacing.
6) After 31,8 F, 1 kg of $NaHCO_3$ was added to the anolyte.
7) By 41,6 F, the precipitate in the anolyte was black.

Table A10-3
Physical and Analytical Data for Nickel Anodes (Pilot Plant Exp. 20 Carbonation)

Anolyte	115 g/l $NaHCO_3$
Catholyte	12 litres NaOH
Absorption column	60 litres effluent + 50 g/l $NaHCO_3$

Time (h)	CD (A/m^2)	F	over-all (V)	cell (V)	mem. (V)	cath. - mem. (V)	anode-mem. (V)	Temp (°C)	Vol. (l)	Sample	pH	L (mS/cm)	OH (g/l)	CO_3 (g/l)	HCO_3 (g/l)	Total CO_2 (g/l)	Na (g/l)	Ni (g/l)
0,00	160	0,0	2,8					30	20,0	anol.	7,8	54	0,0	6,5	53,9	44,1	21,4	2,4
	300		3,3	3,2					32,0	cathol.			11,9	30,0	0,0		43,7	
	400		3,5	3,4					60,0	column	8,9	47	0,0	12,0	32,2	32,3	21,0	
	700		4,2	3,8														
	1000		4,9	4,7														
	1400		6,2	5,6														
	2000		6,9	6,3	0,19	2,6	3,6											
	3000		9,3	8,2														
	4000		10,7	9,4	0,10	2,0	2,7	40										
0,45	2000	2,6	5,9	5,3				49	16,0	anol.	7,6	61	0,0	12,7	57,3	51,1	28,0	
1,55	200	6,9	2,4	2,4					35,6	cathol.			15,3	30,0	0,0		43,9	
	700		3,2	3,0					60,0	column	8,7	47	0,0	8,2	42,0	38,0		
	1000		3,6	3,3	0,03	2,0	2,7											
	1400		4,1	3,7														
	2000		5,3	4,8														
	3000		6,5	6,5														
	4000		8,4	7,0														
	6000		11,0	9,4														
3,00	7000	10,9	5,2	4,7	0,03	1,8	2,7	55	14,0	anol.								
									11,7	cathol.								
									39,4	column								
4,00	200	14,8	2,3	2,3				61										
	600		2,9	2,8														
	1000		3,4	3,2														
	1500		4,1	3,7														
	2000		5,2	4,7	0,03	1,8	2,8											
	3000		6,3	5,3														
	4000		8,5	7,3														
	6000		11,3	9,7														
5,00	200	18,1	2,3	2,3				60	11,0	anol.	7,4	51	0,0	8,4	45,9	39,6	21,5	2,6
	600		2,9	2,8					42,9	cathol.			14,5	33,0	0,0		46,5	
	1000		3,4	3,2														
	1500		4,1	3,7														
	3000		6,1	5,3														
	4000		7,6	6,5														
	6000		11,2	9,6														
7,55	600	25,4	2,8					68										
	1400		3,9	3,6														
	2000		4,6															
	3000		5,9															
	4000		7,311															
	6000		0,6															
8,45	1000	27,1	3,3	3,1		1,2	1,7	67	15,9			49	0,0	12,0	34,2	33,7	19,6	
	2000		4,4						34,8				17,0	30,0	0,0	21,9	52,5	
	3000		5,6	4,8														
	4000		6,8															
	6000		9,4	7,9														
10,00	1000	29,6	3,2					64	18,3	anol.	8,7	53	0,0	17,3	25,6	31,3	22,4	4,0
	2000		4,4						32,3	cathol.			21,3	27,0	0,0		53,7	
	3000		5,5															
	4000		6,5															
	6000		8,9															

Comments

1) After 0,0 F continued to run at 1 000 A/m^2.
2) After 1,55 F continued to run at 1 000 A/m^2.
3) After 4,00 F continued to run cell at800 A/m^2 (4,2 volts).
4) After 5,00 F continued to run cell at700 A/m^2 (3,9 volts).
5) After 7,55 F continued to run cell at 500 A/m^2 (3,4 volts).

Table A10-4
Physical and Analytical Data for Nickel Anodes (Pilot Plant Exp. 20A)

Anolyte	20 litres nanofiltrate from exp. 20
Catholyte	15 litres 10 % NaOH
Absorption column	60 litres effluent + 50 g/l $NaHCO_3$

Time (h)	CD (A/m^2)	F	over-all (V)	cell (V)	mem. (V)	cath. - mem. (V)	anode-mem. (V)	Temp (°C)	Vol. (l)	Sample	pH	L (mS/cm)	OH (g/l)	CO_3 (g/l)	HCO_3 (g/l)	Total CO_2 (g/l)	Na (g/l)	Ni (g/l)
0,00	20	0,0	1,9					21	20,0	anol.	8,9	56	0,0	0,4	23,2	23,1	26,6	
	200		2,6						15,0	cathol.		20	38,4	2,4	0,044	1,8	62,1	
	1000		4,2						60,0	column	9,4	55	0,0	18,0	5,2	46,1	27,5	
	1600		5,2															
	2000		5,8	4,6	0,10	2,1	3,0											
1,35	200	5,6	2,4	2,3				48										
	100		3,5	3,3														
	1600		4,3	3,9														
	2000		4,9	4,4														
	2400		5,4	4,8														
	3000		6,1	5,4														
	4000		7,4	6,4														
	5000		8,7	7,4														
	6000		10,3	8,7														
	7000		11,9	10,2														
3,00	2000	11,0	4,9	4,2	0,10	1,6	2,5	50	12,3	anol.	7,2	51	0,0	4,9	25,6	22,3	28,7	
									15,4	cathol.		24	36,7	2,4	0,0	1,8	55,2	
									60,0	column	9,4	55	0,0	16,9	30,5	34,6	27,3	
	1600		4,3	3,8	0,01	1,5	2,2											
4,50	200	16,7	2,3	2,3														
	1000		3,7	3,3														
	1600		4,8	4,3														
	2000		5,2	4,6														
	3000		6,9	6,3														
	4000		15,9	13,9														
5,00	1600	17,0	4,8					57										
	1200		4,1															
6,35	1200	20,6	4,9	4,4	0,10	1,5	2,8	58	18,3		6,4	39	0,0	0,0	12,3	9,0	18,7	
									16,2			25	42,3	4,3	0,0	3,6	12,9	
									60,0		9,2	55	0,0	14,4	37,8	38,1	39,8	

Comments

1) After 0,0 F continued to run at 2 000 A/m^2.
2) After 3,0 F turned current down.
3) After 5,0 F turned current down.
4) After 14,8 F turned current down.

Table A10-5
Physical and Analytical Data for Nickel Anodes (Pilot Plant Exp. 20B)

Anolyte: 18 litres nanofiltrate from exp. 20
Catholyte: 15 litres 20 % NaOH
Absorption column: 60 litres effluent + 50 g/l $NaHCO_3$

Time (h)	CD (A/m^2)	F	over-all (V)	cell (V)	mem. (V)	cath. - mem. (V)	anode-mem. (V)	Temp (°C)	Vol. (l)	Sample	pH	L (mS/cm)	OH (g/l)	CO_3 (g/l)	HCO_3 (g/l)	Total CO_2 (g/l)	Na (g/l)	Ni (g/l)
0,00	20	0,0	2					24	18,0	anol.	9,2	56	0,0	8,4	23,2	23,1	25,6	
	200		3						15,0	cathol.		42	63,8	6,0	0,0	4,4	99,3	
	1000		5						60,0	column	9,5	49	0,0	14,5	25,5	29,2	26,2	
	2000		6	5,7	0,07	1,8	3,7											
0,45	200	2,9	3	2,4				39										
	1000		4	3,6														
	1600		5	4,3														
	2000		6	5,0														
	3000		7	6,2														
	4000		9	8,1														
	5000		16	14,0														
1,30	2000	6,0	5	4,8	0,04	1,6	3,1	42	17,3	anol.	8,0	47	0,0	3,7	17,0	15,1	18,9	
									15,7	cathol.		37	67,2	3,0	0,0	2,2		
									40,0	column	9,5	49	0,0	15,6	25,6	30,1		
2,45	200	8,8	2	2,3														
	1000		4	3,5														
	1600		5	4,5														
	2000		7	6,4														
	3000		9	8,2														
	4000		18	16,0														
4,00	200	14,8	3	2,3				55	16,8		7,3	35	0,0	0,0	7,3	5,3	11,5	
	1000		4	3,8					16,4			38	65,5	3,0	0,0		96,9	
	1600		7	5,9					60,0		9,3	49	0,0	12,1	31,6	31,9		
	2000		7	6,0														
	3000		13	12,0														

Comments
1) After 0,0 F continued to run at 2 000 A/m^2.
2) After 1,30 F at this stage the anolyte contained a pale green precipitate.
3) After 4,00 F at this stage the anolyte started turning black and contained a grey precipitate. The experiment was stopped.

Table A10-6
Physical and Analytical Data for Nickel Anodes (Pilot Plant Exp. 21A)

Anolyte: 13 litres nanofiltrate from exp. 21
Catholyte: 15 litres 10 % NaOH
Absorption column: 60 litres effluent + 50 g/l $NaHCO_3$ (from exp. 20B)

Time (h)	CD (A/m^2)	F	over-all (V)	cell (V)	mem. (V)	cath. - mem. (V)	anode-mem. (V)	Temp (°C)	Vol. (l)	Sample	pH	L (mS/cm)	OH (g/l)	CO_3 (g/l)	HCO_3 (g/l)	Total CO_2 (g/l)	Na (g/l)	Ni (g/l)
0,00	20	0,0	2,00					21	13,0	anol.	9,2	39,0	0,0	5,0	19,2	17,6	15,6	0
	200		2,00						15,0	cathol.		22,0	38,3	3,0	0,0	2,2	63,4	
	1000		5,10						60,0	column	9,3	50,0	0,0	12,1	4,9	30,1	25,2	
	1600		6,50															
	2000		7,90	7,1	0,06	1,9	5,0											
	3000		10,10															
	4000		13,00															
1,55	200	6,9	2,50	2,3				52										
	1000		4,20	3,8														
	1600		5,50	4,9														
	2000		7,00	6,3														
	3000		9,40	8,6														
	4000		17,60	15,5														
2,35	200	9,4	2,60	2,4					12,2	anol.	7,4	28,0	0,0	4,2	21,7	12,4	10,2	
	1000		6,10	5,7					15,7	cathol.		26,0	42,5	3,6	0,0	2,4	74,6	
	1600		8,60	7,8					60,0	column	9,2	50,0	0,0	10,2	31,6	31,0		
	2000		10,20	10,2														
	2600		15,50	15,0														
3,00	1600	10,7	12,90	12,0					11,9	anol.	6,8	25,0	0,0	2,5	19,5	16,1	9,2	
									15,7	cathol.		26,0	46,2	2,4	0,0	14,0	76,3	
									60,0	column	9,2	42,0	0,0	12,0	26,9	28,4		

Comments
1) After 0,0 F continued to run at 2 000 A/m^2.
2) After1,55 F at this stage the anolyte contained a green grey precipitate.

Table A10-7
Physical and Analytical Data for Nickel Anodes (Pilot Plant Exp. 21B)

Anolyte	14 litres nanofiltrate from exp. 21
Catholyte	15 litres 15 % NaOH
Absorption column	60 litres effluent + 50 g/l $NaHCO_3$ from exp. 21A

Time (h)	CD (A/m^2)	F	over-all (V)	cell (V)	mem. (V)	cath. - mem. (V)	anode-mem. (V)	Temp (°C)	Vol. (l)	Sample	pH	L (mS/cm)	OH (g/l)	CO_3 (g/l)	HCO_3 (g/l)	Total CO_2 (g/l)	Na (g/l)	Ni (g/l)
0,00	20	0,0	2,4					22	14,0	anol.	9,8	49	0,0	14,4	7,4	15,9	20,9	5
	200		4,3						15,0	cathol.		23	53,0	1,2	0,0	0,7	78,6	
	800		13,0	12,3	0,05	1,9	10,0		60,0	column	9,4	50	0,0	10,8	28,1	28,2	24,2	
	1000		17,5															
	1600		25,4															
2,20	200	3,5	3,6	3,4				50	13,4	anol.	9,0	48	0,0	10,9	12,1	16,8	19,1	2
	800		7,3	6,8					15,4	cathol.			57,1	1,6	0,0	1,2	84,7	
	1000		8,5	7,8					60,0	column	9,5	51	0,0	13,3	24,3	27,1	23,1	
	1600		11,6	10,6														
	2000		13,4	12,3														
	2400		15,7	14,3														
4,00	1600	8,8	9,4	8,6				57	12,6	anol.	8,1	43	0,0	7,2	13,5	15,1		
									16,1	cathol.			55,9	3,6	0,0	2,6	82,2	7
									60,0	column	9,4	50	0,0	13,3	23,2	27,3	23,0	
4,00	40	8,8	3,1					24		anol.								
	200		6,9							cathol.								
	1000		19,3	14,2	0,20	1,7	11,3			column								
4,40	200	10,0	3,4					35	12,3	anol.	7,6	37	0,0	7,2	17,10	17,0	15,8	19
	1000		8,1	7,5					16,3	cathol.			53,0	4,8	,0	3,5	79,0	
	2000		12,8	11,6					60,0	column	9,5	49	0,0	12,1	25,6	27,5		
	2400		14,5	13,1														
	2600		15,2	13,9														
6,05	2000	14,2	15,6	14,5				52	11,2	anol.	7,0	31	0,0	2,5	15,7	13,3	10,0	38
									16,7	cathol.			55,3	3,6	0,0	2,2	85,4	
									60,0	column	9,3	48	0,0	10,8	29,2	29,2		

Comments

1) After 0,0 F continued to run at 1 600 A/m^2.
2) After 2,20 F continued to run at 1 600 A/m^2.
3) After 4,00 F stopped experiment overnight.
4) After 4,00 F continued to run at 1 000 A/m^2.
5) After 4,40 F at this stage the anolyte started going black.
6) After 4,40 F continued to run at 2000 A/m^2.

Table A10-8
Physical and Analytical Data for Nickel Anodes (Pilot Plant Exp. 21C)

Anolyte	13 litres nanofiltrate from exp. 21
Catholyte	15 litres 20 % NaOH
Absorption column	60 litres effluent + 50 g/l $NaHCO_3$ from exp. 21B

Time (h)	CD (A/m^2)	F	over-all (V)	cell (V)	mem. (V)	cath. - mem. (V)	anode-mem. (V)	Temp (°C)	Vol. (l)	Sample	pH	L (mS/cm)	OH (g/l)	CO_3 (g/l)	HCO_3 (g/l)	Total CO_2 (g/l)	Na (g/l)	Ni (g/l)
0,00	20	0,0	2,3					23	13,0	anol.	9,3	41	0,0	7,2	15,8	16,8	15,2	7,0
	200		7,2						15,0	cathol.		39	66,0	8,4	0,0	6,1	22,8	
	600		16,3	15,8	0,10	1,6	13,3		60,0	column	9,6	48	0,0	10,9	31,7	31,1	27,1	
	1000		25,4															
1,15	200	1,4	4,2	4,1				42										
	600		8,0	7,5														
	1000		11,7	10,7														
	1600		16,0	14,5														
	1800		16,7	15,6														
	3200		25,4	23,4														
3,45	200	6,3	4,4	4,2				58	12,3	anol.	8,8	40	0,0	7,2	14,6	15,9	14,2	
	1000		11,2	10,5					15,8	cathol.								
	1600		15,6	14,3					60,0	column	9,3	49	0,0	10,8	31,7	31,1		
	1800		16,6	15,4														
	3000		23,8	21,9														
	3300		25,4	23,3														
4,25	1000	10,9	12,7	11,9				60										
4,25	1500	10,9	16,2	15,0				25	12,3	anol.	8,9	38	0,0	4,8	18,2	16,8	13,9	
									15,8	cathol.			71,7	4,8	0,0	3,5	95,6	
									60,0	column	9,5	49	0,0	13,3	26,8	29,3		
5,10	1500	13,1	17,8	16,9				40										
	1200		15,8	14,9														
6,00	1200	15,0	17,9	17,0				57										
	800		14,0	13,0														
7,05	800	16,6	15,0	14,1				60										
	600		12,1	11,6														
8,00	600	17,7		11,8	0,16	1,6	10,0	60	7,7	anol.	7,7	28	0,0	1,8	12,3	10,7	9,3	7,0
									17,2	cathol.		39	69,0	2,4	0,0	1,8	92,3	
									60,0	column	9,7	49	0,0	13,2	26,9	29,3		

Comments
1) After 0,0 F continued to run at 1 000 A/m^2.
2) After 10,9 F the experiment was stopped overnight a leak in the catholyte side was fixed.
3) After 13,1 F turned current down.

Experimental Data for Laboratory Tests

Table A10-9
Physical and Analytical Data for Nickel Anodes (Laboratory Study)

Anolyte	5 litres of 50 g/l $NaHCO_3$ and 20 g/l Na_2CO_3
Catholyte	5 litres 10 % NaOH
Current	2A

Time (h)	CD (A/m^2)	F	Overall volts (V)	mem. Volts (V)	Anode mass (g)	Temp (°C)	Vol. (l)	Sample	pH	OH (g/l)	CO_3 (g/l)	HCO_3 (g/l)	Total CO_2 (g/l)	Na (g/l)	Ni (g/l)
0-00	2000	0,00	25,0	7,3	13,198	23	5,0	anolyte	9,6	0,0	15,1	28,9	32,1	20,0	1
							5,0	catholyte		38,0	1,8	0,0	1,3	55,4	
5,25	2000	0,42		6,6		32									
22,15	1500	1,36	20,0	7,0	13,028	30	4,8	anolyte	9,1	0,0	10,3	25,7	26,3	17,3	16
							5,0	catholyte		42,2	3,6	0,0	2,2	59,4	
28,00	1500	1,68													
44,15	1000	2,29	18,0	5,7	12,689	27	4,3	anolyte	8,6	0,0	12,4	14,4	19,6	14,0	74
							4,8	catholyte		43,9	4,8	0,0	2,9	66,1	
68,45	1500	3,66	25,5	10,3	12,215	30	4,1	anolyte	8,6	0,0	7,4	14,2	15,8	12,3	90
							4,8	catholyte		44,0	6,0	0,0	4,4	71,6	
98,45	1500	5,34	36,0	11,5	10,562	30		anolyte	8,7	0,0	2,5	17,3	14,5	7,5	168
							4,7	catholyte		49,0	9,0	0,0	5,4	72,0	

Comments
1) After 0,42 F the current was turned down to 1,5 A overnight (Vmem = 5,0).
2) After 1,36 F the anode wire connection sheared at this stage - it was resoldered and the anode was sanded: 13 008 g. Minimal pitting corrotion was visable at this stage.
3) After 1,68 F turned down current 1A overnight. During the night the power tripped.
4) After 2,29 F the anode at this stage was coated in a black deposit which was wiped off before weighing. The current was turned up to 1,5A V(ov) = 23,0,V(mem) = 7,6.
5) After 3,6F the anolyte at this stage contained a black precipitate.
6) After 5,34 F at this stage the cell leaked on the anolyte side and approximately 1,9L had been lost, 2L remained.

Table A10-10
Current Efficiency Data for Nickel Anodes (Laboratory Study)

Sample	F	Theoretical Change (mol)	Na Species Total (g)	Na Species Obs. change (mol)	Na Species CE (%)	Carbonate/Bicarbonate Species Total CO_3 (g)	Total CO_2 (g)	Obs. change CO_3 (mol)	Obs. change CO_2 (mol)	Total change (mol)	CE (%)	OH Species Total (g)	Obs. change (mol)	CE (%)
anolyte	0,00	0,00	100			76,0	161,0							
catholyte			277									190,0		
anolyte	1,36	1,36	83	0,74	54,00	49,0	126,0	0,4	0,8	1,2	90			
catholyte			297	0,87	64,00							211,0	1,2	91,0
anolyte	2,29	2,29	60	1,74	76,00	53,0	84,0	0,4	1,7	2,3	100			
catholyte			317	1,74	76,00							211,0	1,2	52,0
anolyte	3,66	3,66	50	2,20	60,00	30,0	65,0	0,8	2,2	3,0	82			
catholyte			344	2,90	80,00							211,0	1,2	34,0
anolyte	5,34	5,34	34*	2,90	54,00	19,0	61,0	1,0	2,3	3,3	62			
catholyte			338	2,70	50,00							313,0	7,2	100,0

* Calculated assuming that the 1,9 l lost had an average of Na concentration of 10 g/l, $CO_3^{=}$ of 1,5 g/l and CO_2 of 17 g/l.

APPENDIX 11

SPREAD SHEET FOR DESIGN CALCULATIONS

Determinand	Symbol	Unit	Equation
1. WASHING VARIABLES			
Moisture content of cloth into wash range	mi	l/kg cloth	Specified
Na conc of moisture on cloth into wash range	ci	g/l Na	Specified
Moisture content of cloth out of wash range	mo	l/kg cloth	Specified
Na conc of moisture on cloth out of wash range	co	g/l Na	Specified
Average cloth mass	fm	kg/m	Specified
Cloth speed	fs	m/h	Specified
Up time of scouring wash range	tm	h/d	Specified
2. TREATMENT PLANT VARIABLES			
Cross-flow microfiltration water recovery	Rc	%	Specified
Nanofiltration water recovery	Rn	%	Specified
Nanofiltration point Na rejection	r	%	Specified
Electrochemical cell current efficiency	E	%	Specified
Electrochemical cell temperature	T	C	Specified
Electrochemical cell water transport number	nw	g/g	$14.6.e^{-0.0429.C5}$
Electrochemical cell electrolyte length	l	m	Specified
Electrochemical cell average catholyte conductivity	CONDC	S/m	Specified
Electrochemical cell decomposition, polarisation and membrane voltage	Vd	V	Specified
Up time of treatment plant	tp	h/d	Specified
3. WASH-WATER AND EFFLUENT CHARACTERISTICS			
Na conc in total wash water	Cq	g/l Na	Specified
Total wash-water flow	Q	l/kg cloth	Specified
Effluent flow	L1	l/kg cloth	Specified
Na conc in effluent	C1	g/l Na	Specified
4. MASS BALANCE CALCULATIONS			
Wash Range: Mass Na in on cloth	Ni	g/kg cloth	mi.ci
Mass Na out on cloth	No	g/kg cloth	mo.co
Mass Na in effluent	N1	g/kg cloth	L1.C1
Cross-flow microfiltration: Concentrate flow	L2	l/kg cloth	L1(1 - Rc/100)
Na conc in concentrate	C2	g/l Na	C1
Mass Na in concentrate	N2	g/kg cloth	L2.C2
Permeate flow	L3	l/kg cloth	L1 - L2
Na conc in permeate	C3	g/l Na	C1
Mass Na in permeate	N3	g/kg cloth	L3.C3
Nanofiltration: Concentrate flow	L4	l/kg cloth	L3(1 - Rn/100)
Na conc in concentrate	C4	g/l Na	(N3 - N4)/L4
Mass Na in concentrate	N4	g/kg cloth	L4.C4
Permeate flow	L5	l/kg cloth	L3 - L4
Na conc in permeate	C5	g/l Na	$(C3.100/Rn)(1-(1-Rn/100)^{(1-r/100)})$
Mass Na in permeate	N5	g/kg cloth	L5.C5
Electrochemical cell: Mass Na in recovered NaOH	N6	g/kg cloth	N5 - Cq.Q
Recovered NaOH	L6	l/kg cloth	N6.nw/1000
Na conc in recovered NaOH	C6	g/l Na	N6/L6
Depleted brine flow	L7	l/kg cloth	L5 - L6
Na conc in depleted brine	C7	g/l Na	(N5 - N6)/L7
Mass Na in depleted brine	N7	g/kg cloth	C7.L7
Make-up Na as NaOH	N8	g/kg cloth	N0 + N2 + N4
Make-up water	L8	l/kg cloth	Q - L7
5. Na LOSSES			
Na loss from drag-out	loss 1	%	N0.100/Ni
Na loss in cross-flow microfiltration concentrate	loss 2	%	N2.100/Ni
Na loss in nanofiltration concentrate	loss 3	%	N4.100/Ni
Na loss from system	S	%	N8.100/Ni
Savings on existing Na make-up	N9	g/kg cloth	N1 - N8
		%	N9.100/N1
6. WATER LOSSES			
Water loss from system	W	%	L8.100/Q
Savings on existing water make-up	L9	l/kg cloth	L1 - L8
		%	L9.100/L1
7. ELECTROCHEMICAL UNIT OPERATING PARAMETERS			
Maximum anolyte conductivity	CONDA1	S/m	Equation 9.14/1000
Minimum anolyte conductivity	CONDA2	S/m	Equation 9.14/1000
Maximum limiting current density	CD1	A/m^2	2.6.CONDA1.1000
Minimum limiting current density	CD2	A/m^2	2.6.CONDA2.1000
Average limiting current density	CD3	A/m^2	(CD1 + CD2)/2
Minimum anolyte volt drop	VA1	V	l.CD1/CONDA1
Maximum anolyte volt drop	VA2	V	l.CD2/CONDA2
Average anolyte volt drop	VA3	V	(VA1 + VA2)/2
Average catholyte volt drop	VC	V	l.CD3/CONDC
Average cell potential	Vc	V	VC + VA3 + Vd
Electrical requirements	F	F/kg cloth	N6/(23.E/100)
8. ELECTROCHEMICAL UNIT AREA AND POWER REQUIREMENTS			
Specific area requirements	As	m^2/kg cloth	26.8.F/(tp.CD3)
Total area requirements	At	m^2	As./m./s.tm
Power requirements for NaOH production	P	kWh/t NaOH	23000.CD3.At.Vc/N6./m./s.40