ATTACHMENT N

Compatibility Tests

PHREEQC, a U.S. Geological Survey program for speciation, batch-reaction, and inverse geochemical calculations was used to determine the extent of the incompatibility of the anticipated wastewater and formation water. The simulation calculates the saturation indices for minerals that could precipitate on mixing the wastewater with the formation water. The input for the simulation of chemical reactions includes the concentrations of major analytes, the pH, temperature, and the ratios of the mixed test solutions.

No formation water samples or analyses are available from wells within the area of review, or from the adjacent Cheney Ranch Gas Field wells. So for the compatibility tests, the chemistry of the formation water collected from an oil well, 'Omni-National 53-10', API # 01921410, located 18 miles southeast of the PEC site, was applied. The laboratory report for the applied formation water (oil well 'Omni-National 53-10') is included in Attachment N. The chemistry of the wastewater applied to the PHREEQC program is shown in Table N1, Attachment N.

The laboratory analytical report for a sample of formation water obtained from the DOGGR for an abandoned oil well 'Omni-National 53-10', API # 01921410, located 18 miles southeast of the PEC site Attachment N). The Total Dissolved Solids (TDS) for this formation sample is 22,270 mg/L.

Formation Water Sample

The chemistry report of the formation water applied to the compatibility tests is dated March 22, 1984.

The oil well API # is 01921410
Operator: The National Oil Company
Lease: Omni-National 53-10
Field: Cantua Nueva
DOGGR Map Ref: W5-2
Well Location: Lat: 36.467645000; Long: -120.327189000
Section, 10, Range 17S, Township 15E
Well Depth: 8648 feet
Drilled on 9/11/1980; abandoned 10/5/1991

The results for selected mix ratios of the wastewater and formation water compatibility tests are shown on Table T2. A graphic display of the data is presented on Figure N1.

Comments

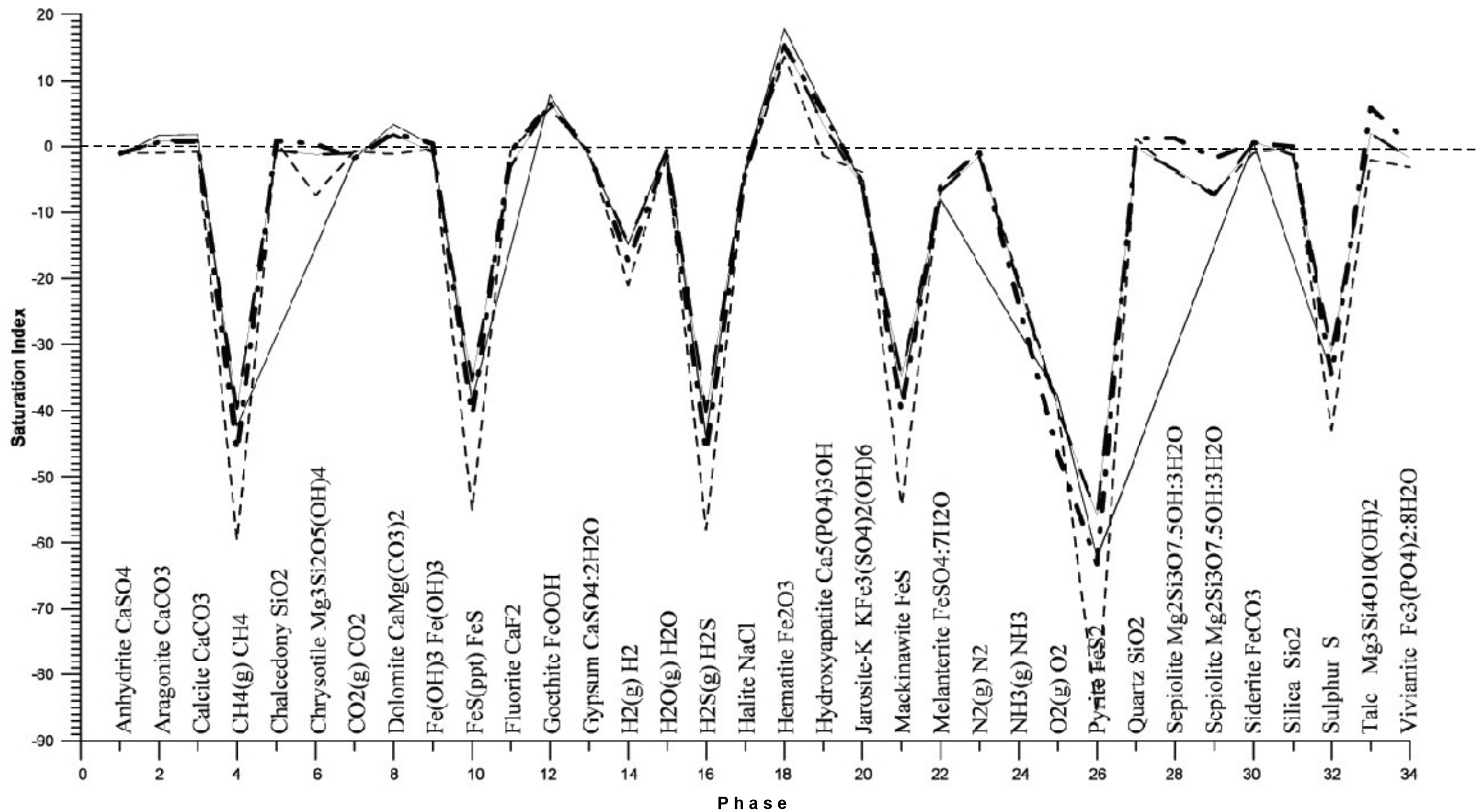
Positive saturation indices for the iron oxides, goethite and hematite, indicate the potential for the precipitation of these minerals, regardless of slight adjustments made to the pH of the wastewater. The simulation indicates a significant reduction in the propensity to precipitate if the wastewater is heated to 200 ^{0}F, prior to mixing with the formation water. In practice, we would expect the wastewater to approach the temperature of the formation water as it flows down the injection tubing. At the estimated maximum injection rate of 531 gpm (71 cu ft), the wastewater would take 9.23.minutes to pass through a 5" diameter tube from the well head to the injection zone at a rate of 8.66ft /second. The temperature of the wastewater would approach that of the formation water by the time it passes through the well screened sections. This would reduce the propensity for the metal oxides to precipitate.

TABLE N1 PROCESS WASTEWATER CHARACTERIZATION

	Units	Cooling Twr Blowdown	Evap Cooler Blowdown	RO System Rejects	Combined Wastewater
General					
pH		7 - 8	7 - 8	7 - 8	7 - 8
Total Suspended Solids	ppm				
Total Dissolved Solids	ppm	5,000	3,000	6,000	5,200
Ion Chemistry, mg/l as $CaCO_3$					
Total Alkalinity		500	350	700	500
Hardness		620	390	780	650
Calcium	Ca	300	200	380	320
Magnesium	Mg	320	200	400	350
Sodium	Na	3,000	2,000	3,700	3,150
Potassium	K	16	10	20	17
Bicarbonate	HCO_3	550	350	700	590
Carbonate	CO_3				
Sulfate	SO_4	800	800	3,000	1,000
Chloride	Cl	450	350	700	550
Nitrate-Nitrite	NO_3	7	4	8	7
Chemicals, mg/l	As Such				
Arsenic	As	.038	.024	.048	.041
Boron	B	10	6	12	11
Cadmium	Cd				
Chromium, total	Cr				
Copper	Cu				
Fluoride	F	2	2	2	2
Iron	Fe				
Lead	Pb				
Manganese	Mn				
Mercury	Hg				
Nickel	Ni				
Phosphorus, total	P				
Selenium	Se				
Silica	SiO_2	135	85	170	145
Silver	Ag				
Vanadium	V				
Zinc	Zn				

TABLE N2 BATCH MIX RATIOS AND SATURATION INDICES FOR MINERAL PHASES

Batch Mix Ratios and pH	Waste water 90% Formation Water 10% pH 7.5			Waste water 90% Formation Water 10% pH 6.0			Waste water 10% Formation Water 90% pH 7.5			Waste water 10% Formation Water 90% pH 6.0			Formation water 10% Formation Water 90% pH 7.9		
Phase	SI	Log IAP	Log KT	SI	Log IAP	Log KT	SI	Log IAP	Log KT	SI	Log IAP	Log KT	SI	Log IAP	Log KT
Anhydrite CaSO4	-0.99	-5.38	-4.39	-0.98	-5.37	-4.39	-1.19	-6.07	-4.88	-0.98	-5.37	-4.39	-1.26	-6.22	-4.97
Aragonite CaCO3	0.69	-7.68	-8.37	-0.92	-9.29	-8.37	0.84	-7.97	-8.81	-0.92	-9.29	-8.37	1.73	-7.15	-8.88
Calcite CaCO3	0.83	-7.68	-8.51	-0.78	-9.29	-8.51	0.95	-7.97	-8.81	-0.78	-9.29	-8.51	1.84	-7.15	-8.99
CH4(g) CH4	-46.26	-89.43	-43.17	-59.69	-62.58	2.88	-39.65	-77.56	-37.91	-59.67	-102.83	-43.17	-42.32	-79.67	-37.35
Chalcedony SiO2	0.84	-2.65	-3.49	0.85	-2.64	3.49	-0.52	-3.57	-3.06	0.85	-2.64	-3.49			
Chrysotile Mg3Si2O5(OH)4	0.45	31.98	31.53	-7.46	24.07	31.53	-1.19	25.72	26.91	-7.46	24.07	31.53			
CO2(g) CO2	-1.75	-19.89	-18.14	-0.72	-2.25	-1.53	-0.95	-19.26	-18.32	-0.72	-18.86	-18.14	-1.82	-20.18	-18.36
Dolomite CaMg(CO3)2	2.07	-15.14	-17.22	-1.10	-18.37	-17.22	1.81	-16.27	-18.07	-1.15	-18.37	-17.22	3.38	-14.79	-18.17
Fe(OH)3 Fe(OH)3	0.47	18.25	17.78	-0.31	4.58	4.89	-0.80	16.10	16.90	-0.31	17.48	17.78	0.22	17.03	16.81
FeS(ppt) FeS	-40.80	-77.56	-36.77	-55.16	-59.07	-3.92	-35.55	66.83	31.29	-55.16	-91.92	-36.77	-38.43	-69.13	-30.70
Fluorite CaF2	-0.67	-11.21	-10.54	-0.66	-11.20	-10.54	-3.00	-13.23	-10.23	-0.66	-11.20	-10.54			
Goethite FeOOH	6.55	18.25	11.70	5.78	4.59	-1.19	6.61	16.11	9.50	5.78	17.48	11.70	7.77	17.03	9.26
Gypsum CaSO4:2H2O	-0.80	-5.38	-4.58	-0.79	-5.37	-4.58	-1.37	-6.08	-4.71	-0.79	-5.37	-4.58	-1.49	-6.23	-4.74
H2(g) H2	-17.39	-17.39	0.00	-20.96	21.15	42.11	-14.58	-14.58	0.00	-20.99	-20.99	0.00	-14.87	-14.87	0.00
H2O(g) H2O	-1.37	0.00	1.37	-1.37	0.00	1.37	-0.42	0.00	0.41	-1.37	0.00	1.37	-0.31	-0.01	0.31
H2S(g) H2S	-46.34	-87.12	-40.78	-58.08	-66.06	-7.98	-40.26	-75.66	-35.40	-58.12	-98.91	-40.78	-43.89	-78.74	-34.84
Halite NaCl	-3.97	-2.38	1.59	-3.97	-2.38	1.59	-3.02	-1.34	1.68	-3.97	-2.38	1.59	-2.97	-1.28	1.69
Hematite Fe2O3	15.14	36.50	21.37	13.59	9.17	-4.42	15.43	32.22	16.79	13.59	34.96	21.37	17.77	34.07	16.30
Hydroxyapatite Ca5(PO4)3OH	5.30	-35.50	-40.80	-1.37	-5.27	-3.90	3.38	-39.75	-43.13	-1.37	-42.17	-40.80			
Jarosite-K KFe3(SO4)2(OH)6	-5.50	23.55	29.05	-3.85	-13.48	-9.63	-6.19	17.36	23.55	-3.85	25.20	29.05	-5.70	17.26	22.96
Mackinawite FeS	-40.06	-77.56	-37.50	-54.43	-59.07	-4.65	-34.81	-66.83	-32.02	-54.42	-91.92	-37.50	-37.78	-69.13	-31.43
Melanterite FeSO4:7H2O	-5.89	-8.03	-2.15	-5.82	-7.97	-2.15	-6.80	-8.58	-1.78	-5.82	-7.97	-2.15	-7.95	-9.69	-1.74
N2(g) N2	-0.65	-3.93	-3.28	-0.73	-3.93	-3.21	-1.47	-4.87	-3.40	-0.65	-3.93	-3.28			
NH3(g) NH3	-23.66	-28.05	-4.39				-20.87	-24.30	-3.43	-29.07	-33.46	-4.39			
O2(g) O2	-46.54	34.77	81.31	-39.37	-42.30	-2.93	-39.71	29.15	68.86	-39.32	41.98	81.31	-37.78	29.74	67.52
Pyrite FeS2	-63.27	-147.30	-84.03	-85.81	-104.14	-18.33	-55.87	-127.92	-72.05	-85.80	-169.84	-84.03	-62.23	-132.99	-70.76
Quartz SiO2	1.26	-2.65	-3.90	1.23	-2.64	-3.87	-0.22	-3.57	-3.36	1.26	-2.64	-3.90			
Sepiolite Mg2Si3O7.5OH:3H2O	1.29	16.91	15.62	-3.98	11.64	15.62	-3.47	11.18	14.64	-3.98	11.64	15.62			
Sepiolite Mg2Si3O7.5OH:3H2O	-1.75	16.91	18.66	-7.02	11.64	18.66	-7.48	11.18	18.66	-7.02	11.64	18.66			
Siderite FeCO3	0.60	-10.33	-10.92	-0.96	-11.88	-10.92	0.71	-10.44	-11.15	-0.96	-11.88	-10.92	0.59	-10.58	-11.17
SiO2	0.02	-2.65	-2.67	0.02	-2.64	-2.67	-1.21	-3.57	-2.36	0.02	-2.64	-2.67			
Sulfur	-34.77	-69.74	-34.97	-42.95	-38.19	4.76	-31.05	-61.09	-30.04	-42.94	-77.91	-34.97	-34.33	-63.86	-29.53
Talc	5.91	26.69	20.78	-2.00	18.79	20.78	2.01	18.57	16.56	-2.00	18.79	20.78			
Vivianite	0.32	-35.68	-36.00	-3.07	-39.07	-36.00	-1.72	-37.72	-36.00	-3.07	-39.07	-36.00			



LEGEND

- Waste water 90% Formation Water 10% pH 7.5
- Waste water 10% Formation Water 90% pH 7.5
- Waste water 90% Formation Water 10% pH 6.0
- Formation Water 100% pH 7.95

CALCULATED SATURATION INDICES FOR MINERAL PHASES, BATCH MIXED FORMATION AND WASTEWATER
PANOCHE POWER PLANT

URS	NO SCALE	CREATED BY: DH	DATE: 08-23-06	FIG. NO
		PM: JM	PROJ. NO: 28906905.00100	N1

ZALCO LABORATORIES
Analytical & Consulting Services

RECEIVED MAR 12 1984

RECEIVED
MAR 22 1984
DIVISION OF OIL & GAS
COALINGA

BLACKHAWK RESOURCES CORP.
STAR ROUTE 4 BOX 6840
BAKERSFIELD CA. 93306
% Joh Marsellos

LABORATORY NO : 1645
DATE RECEIVED : 3/6/84
DATE REPORTED : 3/9/84

SAMPLE DESCRIPTION : OMNI-NATIONAL #53-10 PRODUCED WATER (NATIONAL OIL CO)

GEOCHEMICAL WATER ANALYSIS

CONSTITUENTS	MG/L	MEQ/L	REACTING PERCENT
CALCIUM, CA	357.00	17.81	2.44
MAGNESIUM, MG	64.20	5.27	0.72
SODIUM, NA	7826.91	340.34	46.67
POTASSIUM, K	38.80	0.99	0.13
IRON, FE (TOTAL)	2.40	0.12	0.01
CHLORIDE, CL	12250.00	345.31	47.36
SULFATE, S04	253.00	5.26	0.72
SULFIDE, S	0.00		
BICARBONATE, HC03	853.00	13.97	1.91
CARBONATE, C03	0.00	0.00	0.00
HYDROXIDE	0.00	0.00	0.00
TOTALS (SUM)	21211.73	729.12	100.00
BORON	55.10		
TOTAL DIS SOLIDS (GRAV)	22270.00		
TOTAL HARDNESS AS CAC03	1159.97		
SODIUM CHLORIDE, TOTAL	20634.83		

PH	7.95	PRIMARY	SALINITY	93.35
SPECIFIC GRAVITY @ 60 F	1.016	SECONDARY	SALINITY	2.80
		TOTAL	SALINITY	96.16
ELECTRICAL CONDUCTIVITY, (E.C., MMHO/CM)	35.03	PRIMARY	ALKALINITY	0.00
RESISTIVITY @ 25 C (OHM-METERS)	0.285	SECONDARY	ALKALINITY	3.83
		TOTAL	ALKALINITY	3.83
		LANGELIER	SCALE INDEX	1.81

JIM ETHERTON
LABORATORY DIRECTOR

4309 Armour Avenue Bakersfield, California 93308
(805) 395-0539