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SEPARATIONS AREAS EFFLUENT TREATMENT:  
THE PREPARATION OF A SIMULATED EFFLUENT  
FOR SYSTEM DEVELOPMENT AND TESTING

Introduction

A fundamental parameter in the design of the Effluent Treatment Facility (ETF), the effluent composition, has recently been investigated by analyzing samples from both separations areas. As a result of this characterization program, we can now project the composition of the ETF feed stream. The anticipated feed composition is presented here for the purpose of making system projections; and a formula is provided for a simulant to use in testing evaporation, filtration, and reverse osmosis (RO) equipment. The components in these waste streams which present potential fouling problems for reverse osmosis are calcium, iron, manganese, barium, and aluminum, in combination with carbonate, silicate, and sulfate. Organics, probably in the form of TBP and kerosene, are also present in the combined effluent, which is otherwise dominated by  $\text{NaNO}_3$  and  $\text{HNO}_3$ .

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### Discussion

SRP and SRL are currently involved in a joint effort to design a water treatment system to purify all aqueous effluents from both F and H Areas for release to Four Mile Creek. The Effluent Treatment Facility (ETF) will consist of reverse osmosis (RO) and ion exchange equipment, preceded by a special filtration system.<sup>1</sup> Waste volume will be reduced further by evaporation, and the concentrate will then be immobilized in a concrete wasteform.

A program was initiated in September 1983 to analyze all of the process effluents that are presently being released to seepage basins in the separations areas. Our goal was to provide sufficient information for the design of a facility to decontaminate these effluents, and thus permit the closure of the seepage basins. That program has reached the point where we can project the composition of the combined effluent streams well enough to propose a simulant for laboratory testing and to describe the feed composition for system projections. This information is preliminary to the final report of the effluent characterization study, which will include an analytical description of the process effluents which will comprise the sources of the ETF feed stream.

### Effluents from the Separations Areas

Samples were taken on a weekly basis from automatic sample collection stations located in both F and H Areas. These stations, called the Trebler Monitors, are located just before the seepage basins, and are designed to collect water samples for an entire week, on a flow-proportional basis. A brief summary of the analytical data obtained from these samples is given in Table I. The data for the two areas is combined to simulate the combined feed stream that will be treated by the ETF. The maximum and minimum values of each measurement are also recorded, presenting a more accurate measure of the range that must be accommodated by the ETF.

Note that the "average" pH is derived from the average of the hydronium ion concentration, not from the numerical average of pH values.

### Simulant Preparation

The results of the weekly composite analyses were used to generate a solution composition that can be used to model the performance of filtration and reverse osmosis equipment in the ETF. The seventeen compounds listed in Table II can be used to make up a simulant which contains all of the contaminants which may present a fouling problem for the reverse osmosis stage of the ETF.

A list of the simulant components and their concentrations is given in Table III, assuming that each was added as called for in Table II. The pH may be adjusted freely for specific tests by adding more or less nitric acid. Caustic may also be added, if necessary.

In preparing the simulant, the concentration listed in Table II should be multiplied by the volume of solution desired, in liters, to obtain the number of grams of each chemical that must be added. This simulant formula is based on the average effluent concentration in preference to the weighted average because of its higher magnesium and calcium values. There is not much difference between the two, and slight adjustments can be made to the formula, depending on the variable of importance.

Kerosene and TBP are included in the formula, as they appear to be prevalent in the effluents. Kerosene is only soluble to 70 ppm<sup>2</sup> but it could affect the efficiency of the treatment system by its adsorption.

### Conclusion

The waste water stream will vary considerably from day to day, but the large holding capacity of the ETF can be used to buffer the water treatment equipment from the frequent dramatic swings in salinity and pH that would otherwise prevent the use of RO altogether. The composition of this "averaged" effluent stream is well approximated by the simulant formula reported in Table II. This formula, or something like it should be used for filtration and reverse osmosis experiments, especially where actual composite samples can not be used.

### References

1. C. D. O'Leary and D. W. Gemar, "ETF Basic Data Report", January 16, 1984.
2. T. Sekine and Y. Hasagawa, "Solvent Extraction Chemistry", p. 49, Marcel Dekker, Inc., New York, NY (1977).
3. CRC Handbook of Chemistry and Physics, 60th Ed., R. C. Weast, Ed., p. B-68, CRC Press, Inc., Boca Raton, FL (1979).

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TABLE I

## 200-AREA EFFLUENTS (9-23-83 to 12-15-83)

	<u>F Area</u>	<u>H Area</u>	<u>F/H</u> <u>average</u> (units are	<u>F/H*</u> <u>weighted</u> <u>average</u> mg/Liter)	<u>Maximum</u>	<u>Minimum</u>
Na**	790	21	406	553	1900	8.7
Ca	0.5	8.0	4.3	2.8	33	0
Fe	1.7	3.6	2.7	2.3	25	0
Zn	0.3	0.3	0.3	0.3	1.6	0
NH <sub>4</sub> **	24	11	17.5	20.1	30	2
Ba	0.01	0.05	0.03	0.02	0.25	0
K**	0.67	0.88	0.77	0.74	1.44	0.11
Al	0.78	2.02	0.3	0.18	3.2	0
Mn	0.016	0.560	0.288	0.183	3.20	0
Mg	0.060	0.829	0.444	0.297	4.45	0
NO <sub>3</sub> **	1220	500	859	996	2540	67
CO <sub>3</sub>	95	30	62	75	145	0
NO <sub>2</sub> **	2	1	1.5	1.7	16	0
Cl**	1.2	1.5	1.4	1.3	9.6	0
SO <sub>4</sub>	4.6	5.3	5.0	4.8	31	0
F**	1.5	0.1	0.8	1.1	12	0
Si (Total)	7.1	5.4	6.3	6.6	39	0.6
Si(<0.45 μM)	5.02	5.52	5.3	5.2	22	0.4
P	2.2	0.58	1.4	1.7	4.4	0.09
pH	2.93	2.39	2.58	2.68	12.9	1.42
HEAVY METALS OF INTEREST						
Pb**	0.13	0.18	0.16	0.15	0.55	0
Hg**	.004	.020	0.012	0.009	0.04	0
Cr**	.054	.013	0.033	0.025	0.36	0
Cu**	.011	0.43	0.22	0.14	2.7	0

\*Weighted average is based on 70% of flow from F Area, 30% from H Area.  
(Reference: ETF Basic Data Report, C. D. O'Leary and D. W. Gemar,  
January 16, 1984).

\*\*Not considered a potential foulant.

TABLE II  
SIMULANT PREPARATION

<u>COMPOUND</u>	<u>FORMULA WEIGHT</u>	<u>CONCENTRATION</u> (g/L)
1. NaHCO <sub>3</sub>	84.01	0.10
2. NaNO <sub>2</sub>	69.00	0.0023
3. NaCL	58.44	0.0017
4. Na <sub>2</sub> SO <sub>4</sub>	142.04	0.0074
5. NaF	41.99	0.0011
6. CaCO <sub>3</sub>	100.09	0.0107
7. FeSO <sub>4</sub> ·(NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub> ·6H <sub>2</sub> O	392.15	0.019
8. MnCl <sub>2</sub> ·4H <sub>2</sub> O	197.91	0.00108
9. Zn(NO <sub>3</sub> ) <sub>2</sub>	189.39	0.00087
10. NH <sub>4</sub> NO <sub>3</sub>	80.00	0.0836
11. Ba(NO <sub>3</sub> ) <sub>2</sub>	261.36	0.00004
12. NaNO <sub>3</sub>	84.99	1.257
13. TBP*	266.32	0.013
14. Al(NO <sub>3</sub> ) <sub>3</sub> ·9H <sub>2</sub> O	375.13	0.021
15. Na <sub>2</sub> SiO <sub>3</sub>	284.20	0.027
16. MgCO <sub>3</sub>	84.32	0.0015
17. HNO <sub>3</sub>	63.02	0.241**

\* (30% v/v in kerosene) = 43  $\mu$ L of 30 v/v% TBP in kerosene.

\*\*This is approximately 3.9 ml of 1.0M HNO<sub>3</sub> (for pH adjustment)

TABLE III

SIMULANT CONCENTRATIONS

<u>SPECIES</u>	<u>CONCENTRATION</u> (ppm)*
Na	406
Ca	4.3
Mg	0.44
Fe	2.7
Zn	0.3
NH <sub>4</sub>	19.6
Ba	0.03
K	0.2
Mn	0.3
Al	1.5
NO <sub>3</sub> <sup>-</sup>	1237
HCO <sub>3</sub> <sup>-</sup>	0.02
NO <sub>2</sub> <sup>-</sup>	1.5
Cl	1.4
SO <sub>4</sub>	9.3
F <sup>-</sup>	0.8
CO <sub>2</sub> **	63
TOC (total organic carbon)	26
Si (SiO <sub>2</sub> )	6.3 (13.5)
P	1.5
pH	approximately 2.6

\*1 ppm = 10<sup>-3</sup> grams/Liter

\*\*CO<sub>2</sub> soluble to 97 ppm at 40°C.3 Equilibrium with  
HCO<sub>3</sub><sup>-</sup> calculated at pH = 2.6.

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