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DESIGN BASES AND PERFORMANCE CHARACTERISTICS
OF THE PUREX 241-A WASTE TANK FARM CONDENSATE
DISPOSAL FACILITY

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Prepared by L. R. Michels and L. L. Zahn

July 26, 1956

Process Engineering Sub-Section
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July 26, 1956

C. R. Bergdahl, Head
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DESIGN BASES AND PERFORMANCE CHARACTERISTICS
OF THE PUREX 241-A WASTE TANK FARM CONDENSATE DISPOSAL FACILITY

This letter presents information on the design and operation of the subject condensate disposal system for your use in design studies to rectify its present limitations.

As described in Reference 1, the 241-A Waste Tank Farm employs direct-contact condensers for condensation of waste tank vapors. The composite condenser effluent is discharged to the 216-A-8 Crib for disposal to the ground. The 216-A-8 Crib is a "line-type" crib with a flat bottom, 880 feet long, 20 feet wide, and 7½ feet deep. Crib side walls have a 1 to 2 slope, resulting in a top projected crib width of 50 feet. The crib is filled with 3-in. rock with about 30 per cent void volume.

The present condensate disposal system was designed to provide for "burp" flow of condensate by means of crib surge volume. In the "Design Case" of Reference 1, the normal condensate flow was taken as 450 gpm, and the "burp" condensate flow, as 2900 gpm. The water level was to be at or near the bottom of the crib at the normal rate of condensate flow. During a predicted maximum "burp" of four hours duration, the crib would fill. At the completion of the "burp", the water level in the crib would subside again to complete the cycle. The crib was designed to handle full "burp" flow of condensate (2900 gpm) while running full at a percolation rate of 100 gal./day sq. ft. of projected area. This percolation rate has not been realized in operation of the crib, and, at the present time, disposal of waste tank farm condensate is severely limited. The 216-A-8 Crib is handling only between 400 and 500 gpm without overflowing.

Data on the 216-A-8 Crib Acceptance Test are presented in Table I. The test was of 3½ weeks total duration. For the last 17 days of this test, the crib handled 2000 gpm continuously. The test was not of sufficient duration, however, to assure that the percolation rate had reached a true equilibrium with the crib soil column saturated with water.

Purex Plant records on the performance of the 216-A-8 Crib during 1956 are presented in Table II. In the last column of Table II, the dates are shown when the waste tanks reached boiling and when waste was rerouted from Tanks 1K-101 to 102 and from 102 to 103. The first waste tank "burp" occurred on

Reference 1: HW-34075, "Purex Facility, Project CA-513-A, Additional Crib Facilities For 241-A Tank Farm Condenser Effluent", by JB Fecht, December 21, 1954.

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7-5-56; "burps" have occurred on a daily basis since this date. To date, the maximum "burp" intensity has been about 20 million BTU/hour, with "burps" lasting about 15 minutes. Waste tank circulators are not in operation as yet, owing to malfunction of the unloaders on the circulator compressors.

Reference 2, attached, summarizes the results of preliminary studies by Aquatic Biology on the condensate disposal system. Three extraneous factors are undoubtedly contributing to the poor performance of the 216-A-8 Crib:

1. Varying quantities of organic material (TBP-kerosene) have been introduced into Waste Tanks 101, 102, and 103, and apparently have been distilled overhead into the contact condenser and crib. Significant quantities of organic emulsion were noted in the crib proportional sampler on July 17, 1956 when the condenser effluent was sampled, and emulsion has been noted on other occasions in the crib overflow stream.

The presence of gross quantities of organic solvent in the 216-A-8 Crib System is undesirable from the standpoint of reduced crib percolation rate and possible explosive hazard at the design temperature range of 175 to 200°F specified in Reference 1. We understand that steps are to be taken at Purex to minimize the routine jetting of organic solvent in the carbonate stream from Tanks G-8 and R-8 into the waste tanks.

2. The presence of fine, suspended river silt in the raw water has been verified.
3. Fungal slime was noted in the condensate sample taken on July 17, 1956.

The maximum rate of heat generation in the waste tank farm is a function of the plant processing rate, reactor power level, slug exposure, slug cooling time, and final waste volume. Figure I shows a plot of normal maximum 241-A Waste Farm heat generation versus reactor power level and Purex Plant capacity factor, at a slug exposure of 500 MWD/T, an initial cooling period of 90 days, and a final waste volume of 100 gallons per ton. For the design case at hand, it is believed that a capacity factor of 4.0 and a reactor power level of 7.5 MW/T would be reasonable assumptions to be used in predicting the ultimate demands upon this system. For this case the normal maximum condensate rate would be 1,340 gpm. This corresponds to a normal heat duty of 32.0×10^6 BTU/Hour. The abnormal "burp" flow would still be considered to be 2900 gpm.

In addition to reducing the amount of organic solvent fed to the waste tanks, the following alternates should be considered, either singly or in combination, for improving the operation of the present 216-A-8 Crib and in the scoping of additional facilities for condensate disposal:

Alternates For Improving Crib Operation

1. Increase the tank farm condenser effluent temperature from 100°F to the design temperature of 175°F to destroy the present micro-organisms in

Reference 2: Letter, LR Michels from RC Pendleton, "Reduced Percolation In Condensate Crib", July 18, 1956.

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the crib. Continued operation at this temperature should prevent the future growth of organisms. Increased temperature should be advantageous in solubilizing trace organic solvent fed to the crib during normal operations and should reduce present demands on the crib.

2. Addition of chemicals or detergents to solubilize organic solvents in the event that increased temperature alone proves inadequate.
3. Improved operation of present silt removal facilities in the raw water supply system to the 200 Areas.
4. Addition of chemicals to the condenser effluent to coagulate the silt fed to the crib.
5. Substitution of new raw water for effluent raw water to condense tank farm vapor. For the same terminal temperature as specified in Reference 1, flow to the 216-A-8 Crib can be reduced by a factor of 2 owing to the greater temperature rise which is possible with new raw water. The Purex raw water system appears to have adequate capacity for this incremental use. Only minor piping changes would be required to supply raw water continuously to the tank farm condensers.

Design Alternates For Increased Capacity

Even though the above corrective action might restore crib percolation rate to a reasonable value, design studies should be initiated immediately on additional crib capacity. To date, feed to the crib has contained almost insignificant quantities of radioactivity and crib overflow has not presented a hazard. However, the increased level of Purex operations is expected to result in increased heat duty and increased flow to the crib. With increased duty, crib overflow might become hazardous. Design alternates are as follows:

1. Provide auxiliary crib capacity.
2. Provide improved silt removal facilities at Purex for cribs which normally dispose of raw water. The 216-A-9 Crib for the Vacuum Fractionator is designed to crib about 600 gallons per minute of new raw water at design capacity.
3. Surface condensers might be considered to replace contact condensers at the tank farm in the event that a high capital cost would be involved in enlarging the present 216-A-8 Crib. The present 216-A-8 Crib would be adequate to handle condensed tank farm vapor, and cooling water from surface condensers could discharge into the swamp.
4. Substitution of new raw water for used raw water might possibly preclude the need for additional crib facilities.

Separations Design & Development will be pleased to cooperate in expediting the necessary design studies. L. R. Michels will serve as Separations Design contact in this work.

LL Zahn, Jr.
Separations Design & Development
Design Section
ENGINEERING DEPARTMENT

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Attachments: Table I
Table II
Reference 2

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TABLE I
A-8 CRIB ACCEPTANCE TESTING

<u>SHIFT</u>	<u>DATE, 1955</u>	<u>FLOW, GPM</u>	<u>COMMENTS</u>
	9-23	2500	started water to crib
	9-24		water level 14' (?) in crib turned off water dropped 3 ft. in 6½ hrs
	9-24	2400	started water water level rising
12-8	9-25	2400	gives 1"/hr rise now at 5-6' in crib
8-4		2100	1"/8 hr rise
4-12		1800	6"/8 hr rise
8-4	9-26	1400	level dropping 2"/hr
4-12		1050	level dropping 2"/hr
12-8	9-27	880	level dropping
8-4		2800	trying to establish 7' level
4-12		2800	3/4"/hr rise
12-8	9-28	2500	
8-4		2800	
4-12		2500	overflowed at #5 riser cut to 2000 gpm
12-8	9-29	1800	crib level 6' running out lower end
8-4		2000	
4-12	9-30	2000	holding even
12-8	10-1	2000	level even
8-4		2000	level even
	10-1 to 10-10	2000	level even
8-4	10-10	2000	level rising
	10-10 to 10-17	2000	level even
	10-17	500	test terminated

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TABLE II
PUREX PLANT CRIB RECORD - 216-A8 CRIB

DATE 1956	TIME	LEVEL RISER #1 INCHES	LEVEL RISER #4 INCHES	FLOW INTEGRATOR OR FLOW METER READING	CALCULATED GPM AVERAGE	REMARKS
1-26	11:10 am	16'-2 (?)	14'2 (?)	500 GPM	500	
1-27	2:30 pm	20	42	520 GPM	520	
1-30	2:15 pm	27-3/4	51-1/2	500-2800	500-2800	
2-1	2:30 pm	22-3/4	46	0117444300	-	
2-3	11:00 am	22-1/2	45-1/2	0118522100	370	
2-8	1:30 pm	25-3/4	49	520 GPM	520	
2-9	2:00 pm	25	48	520 GPM	520	
2-13	2:00 pm	24-1/2	47-1/4	485 GPM	485	
2-14	2:10 pm	24	46	485 GPM	485	
2-16	10:00 am	21-3/4	45	485 GPM	485	
2-18	10:30 am	22-1/4	46-1/2	485 GPM	485	
2-22	10:30 am	23-3/4	47	485 GPM	485	
2-23	11:10 am	23-3/4	47	485 GPM	485	
3-1	2:30 pm	46	68	500-3000 GPM	500-3000	
3-8	11:00 am	42	64	525	525	
3-16	2:30 pm	41-1/2	63-1/2	141936400	-	3/21-Waste routed from TK-101 to TK-102
3-26	2:10 pm	23	45 1/2	145565200	420	3/23-TK 101 reached 98°C
4-2	2:10 pm	19	41	148044400	246	
4-10	11:20 am	19	41	500 GPM	500	
4-13	10:40 am	15-1/2	38	151786800	-	
4-18	2:40 pm	26-3/4	50	153054300	170	
4-23	1:20 pm	18-3/4	41	154782000	240	
4-26	1:40 pm	19	41-1/2	155920500	264	
4-30	1:40 pm	35	57	157377200	250	
5-8	1:30 pm	42-3/4	65-1/2	160366200	260	5/2-TK-102 reached 99°C
5-17	2:00 pm	33-1/4	56	163433300	240	5/14-Waste routed from TK-102 to TK-103
5-23	1:00 pm	24	47	163616900	217	
5-28	1:20 pm	17-1/2	41	164732900	160	
6-11	11:10 am	4-3/4	32	169449900	233	
6-18	2:20 pm	2	32	171838000	238	
6-25	11:30 am	6	33	174280800	242	6/25-TK-103 reached 102°C (boiling)
7-2	10:40 am	34	56	176649300	235	7/5 First Waste Tank "Burp"
7-9	2:00 pm	80	103	182507400	580	216-A8 crib over- flowing
7-12	2:00 pm	78	100	-	-	crib overflowing
7-13		78	100	186617500	715*	
7-14	1:00 pm	77-1/4	87-1/2	187224700	440	
7-15	10:35 am	76-3/4	99-1/2	187783700	430	crib overflowing
7-16	10:30 am	76-1/4	99	188513800	502	
7-17		72	94-1/2	188958500	310?	crib not overflowing

* Average 7/9 to 7/13

July 18, 1956

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L. R. Michels
275-EA Building
200-E Area

REDUCED PERCOLATION IN CONDENSATE CRIB

In reply to your request for information as to the cause of reduced percolation in the "condensate" crib the following is submitted:

Basic Conditions:

1. Percolation reduced by three-fourths. Reduced percolation noticed during last month.
2. Water used as coolant is untreated raw water. During the last three months this has probably had a suspended-solids content of 500 ppm and under normal conditions about 2 ppm.
3. Water temperature 39° C on entering the crib. This temperature is border-line for most aquatic organisms.
4. Raw water reservoir in 200-E Area affords no settling time to remove suspended solids.
5. Raw water pH 7.5 to 8; O₂ content 14.5 ppm.

Findings:

1. A large quantity of yellowish oil covers the surface of the water in the sample pit (1/5 of total sample taken).
2. The agitation of the water creates an emulsion that is passed into the crib.
3. Surface of the water covered with a thick layer (to 1/2") of white, fibrous, viscous slime. Investigation of this slime revealed that it was made up of a mass of filamentous fungus. The mass is buoyed up by numerous oil droplets. Many microscopic water plants (phytoplankton) were found imbedded in the fungus mass. They probably afford part of the food base for the fungus, although the finding of numerous oil droplets inside the fungus strands suggests that this plant is capable of utilizing the oils in its metabolism.

None of the personnel of Aquatic Biology recognized this fungus, but an attempt will be made to learn its identity.

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Probable Causes of Reduced Percolation:

1. Fouling of filter surfaces with fine sediments. Because none of the suspended solids are removed from the raw water, the crib is acting as a filter bed. It is highly probable that a part of the reduction is traceable to filling of the interstices in the sand and silt beds with fine clays.

Suggested solution:

- (a) Addition of powdered gypsum to flocculate the clays and reopen the bed. Perhaps better flocculants are available; a chemical engineer could better advise on this. In any event, try to avoid adding any sodium compounds, for these generally make clays less permeable.
 - (b) Installation of a filter to remove silt and clay before it reaches the crib.
2. Packing of filter surface with fungal slime. This is a real possibility. This slime would not float if divorced from the oil droplets. Undoubtedly this happens in the crib. A thin layer of the slime we found would be quite capable of stopping up the filter surface.

Suggested solution:

Step up the temperature to around 90° C. This should kill all the fungi. A check on the floating masses in the sample room will tell you if this is successful. If not, a suitable fungicide can be metered into the line. Avoid using any of the petroleum based fungicides.

Chlorine, Paris green (copper acetoarsenite), and Toxaphene may be useful and would not complicate the filter problem.

High temperature and high oxygen content of the water should help to remove organic materials in the filter.

3. Formation of impervious oil gums. The emulsified oils, coming in contact with the filter surfaces, should form gums and oil surfaces that would gradually reduce the permeability of these layers.

Suggested solution:

Remove oils from influent. This is a common problem in sewage plants, and small oil separation or skimming plants are commercially available. For practicability or design consult a sanitary engineer.

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L. R. Michels

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July 18, 1956

Suggested Studies to Resolve Problem

The problem of blocking of the filter surface by oil emulsion should be capable of solution by adding an emulsion of the oil on the surface of the sample pit to soil columns. Randy Brown could set this up. If a reduction in percolation rate is demonstrated by such a test, the same treated soil columns could subsequently be subjected to various detergents to find a suitable means of breaking up the impervious layer.

Because the raw water contains relatively large amounts of basic salts which could react with detergents to worsen the situation, I should strongly advise against massive detergent treatment until after soil column tests prove whether this avenue of attack is feasible.

There are special oil detergents available that might be used, but most of these are only slightly miscible with water. One long-shot suggestion is N, N - Dimethylformamin supplied by Du Pont.

/s/

R. C. Pendleton
AQUATIC BIOLOGY UNIT

RC Pendleton:mb

cc: HA Kornberg
RF Foster
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