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FINAL REPORT - PRODUCTION TEST IP-740
PHOSPHATE CAPTURE SUBSEQUENT TO FILTERING

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May 5, 1965

FINAL REPORT - PRODUCTION TEST IP-740
PHOSPHATE CAPTURE SUBSEQUENT TO FILTERING

INTRODUCTION

Alum is used as the coagulating agent in the water treatment process at Hanford. The bicarbonates present in Columbia River water react with the alum to form a loosely knit aluminum hydroxide molecule.

Finely divided particulate matter and large organic molecules present in raw water are adsorbed by the floc particles. Partial removal is accomplished by settling in the basins; however, gravity filter beds remove the greater part of the suspension load. A polyacrylamide is added to the filter inlet stream to form a binding net around the floc particle. The floc particle is now more resistant to shearing and a greater amount of small particles are retained in the filter bed.

The objective of this test was to re-capture parent isotopes of phosphorous and arsenic that had passed through the filters by secondary alum coagulation. The size and density of the floc particle would be increased by employing bentonite for the nucleus. The larger particles should now pass through the reactor with minimum residence time for activation. A polyacrylamide would again be used to net or toughen the floc particle.

SUMMARY

Post filtration alum/bentonite was added to the far side of H Reactor Plant intermittently during the period of February 15, 1965, to April 4, 1965. Dose rates of both alum and bentonite were varied during the test. During the periods of simultaneous alum and bentonite addition, the test side of the reactor effluent water showed an appreciable initial increase in gross gamma activity. The longest period of continuous alum/bentonite addition was 11 days. The test was terminated because of the interference of the gross gamma activity increase with the fuel element rupture monitoring system. Due to the necessarily short duration of the test runs, no firm conclusions can be drawn concerning the ultimate effect of this method on effluent activity.

The following are observations from the test:

1. The addition of only alum after the filter tended to increase initial process tube filming.
2. Alum plus bentonite additions resulted in film removal and an initial increase in effluent activity.
3. The addition of bentonite downstream of the filters adversely affected the gamma fuel rupture monitoring system to such an extent as to discourage further consideration of this water treatment with the existing rupture monitoring system.

DISCUSSION

Water Flow and Chemical Addition Sequence

This test was started at the conclusion of the water regulation characteristic

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test wherein acid and alum were fed simultaneously to the west (far) half of 183-H head house.⁽¹⁾ Since it was necessary to utilize the post filtration acid facilities to the west (far) plant half for liquid alum addition, the filter effluent water was of comparable quality to that produced by the coagulation test. Sodium dichromate was added in the normal amount of 1 ppm to both plant halves.

The filter plant remained as an identical half system, with the exception that the clearwell inter-tie and the 183 filtered water loop remained open. During this period, however, balanced water flows were maintained through both systems. The process water system from 190 to the reactor front face remained as isolated half plant systems.

Liquid alum was added to the west (far) filter effluent flume by means of a water jet that was located in the head house.

Bentonite slurry was water injected into the west (far) 190 process water pump suction header at its exit from 190 tank room.

Facilities were provided for the addition of a polyacrylamide (Separan, NP-10) upstream of the 190 process water pumps. This test did not proceed to the point of using the polyacrylamide.

Reactor Tube Film and Gross Effluent Activity

Liquid alum was added step-wise (0.5 to 2.0 ppm) to the process water stream for the first four days of the test. An immediate increase in film deposition was experienced. During this period, 15 pre-selected process tubes' Panellit pressures increased an average of 11 psi above base.

On test day four, a bentonite addition of 1 ppm was started and the alum feed remained at 2 ppm. An instantaneous purging reaction was observed which reduced Panellit pressures, and resulted in gross gamma increase of the effluent water. The far side gamma monitor readings increased substantially both in magnitude and spread between cross-headers. The near side gamma monitors and Panellit pressures remained normal throughout the test. A quantitative measurement of the gross gamma increase was not obtained since this instrumentation is designed primarily for fuel rupture detection. The instruments are frequently rebased as operating conditions require.

Throughout the test, several reactor operating difficulties were experienced that necessitated temporary stoppages. Coincidentally, during the test period, a high rate of fuel element ruptures occurred. This obviously left some doubt as to the possible test contribution to the adverse operating experience. Subsequent metallographic examination of fuel elements discharged during early March, including three tube charges from each side, revealed no difference between reactor sides. Abnormalities in the fuel elements were observed to have been mechanical damage caused during fuel transport (charge or discharge). Thus, the test is now believed not to have contributed to the fuel failures.

During the periods of simultaneous alum/bentonite additions, high gross gamma activity was experienced in the test side effluent water. This created serious operating

(1) RL-REA-922, Preliminary Investigation of Water Coagulation Characteristics As Affects Reactor Effluent Radionuclides.

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problems since it was necessary to alter cross-header sample water flows several times each shift to rebase the gamma monitors. Contribution to the gross gamma activity by the added chemicals was discounted since spectrochemical analysis of alum and bentonite did not reveal any objectionable elements.

A gamma scan of samples obtained on March 1, 1965, showed the following ratios of radioisotopes:

	<u>Test Side/Control Side</u>
Na ²⁴	1
MN ⁵⁶	3
Ba-La ¹²⁰	2
Cu ⁶⁴	2
Np ²³⁹	2
Cr ⁵¹	1.5
Zn ⁶⁵	1.5
Zr-Nb ⁹⁵	1.5

From March 25 through April 4, the alum/bentonite addition was maintained constant at 1 ppm. The monitored Panellit pressures remained relatively stable, but the gross gamma activity of the effluent water showed no evidence of reducing. Since this phenomena was detrimental to the test objective of lowering effluent activity and to reactor operations, and there was no indication the reactor tube films would stabilize within a reasonable period, it was decided to terminate the test.

Other water plant tests have been characterized by initial increases in effluent activity, which are in some cases followed by decreases in effluent levels. This test did not continue long enough to confirm these phenomena.

Monitored Reactor Effluent Radionuclides

<u>p32</u>	<u>Control Side (Near)</u>	<u>Test Side (Far)</u>
	<u>pc/ml</u>	
Test Average	10.0	10.8
Estimated Base (1)		6.0

(Acid added with bauxite at 183 head house which should produce a 40% base reduction from the control side)

Estimated Increase 44%

As⁷⁶

Test Average	55.8	34.2
Estimated Base (1)		28.5

(Acid added with bauxite at 183 head house which should produce a 49% base reduction from the control side)

Estimated Increase 16.7%

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Cr⁵¹ and Np²³⁹

These radionuclides were not evaluated since split samples were not obtained. To attempt to compare the H composite sample with other reactor plants would be meaningless, due to the various reactor effluent tests in progress.

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FRONT FACE MAP - H REACTOR
PROCESS TUBES MONITORED FOR PRESSURE CHANGES
PT-IP-740

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Test Panellet Gauges
psi - Average Above Base

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PRODUCTION TEST IP-740

H REACTOR EFFLUENT RADIONUCLIDES

pc/ml

	<u>As⁷⁶</u>		<u>P³²</u>	
	NEAR (Control)	FAR (Test)	NEAR (Control)	FAR (Test)
2/16/65	37	20	9.9	(4.3)
17	46	22	9.7	12.0
18	24	33	8.9	20.0
19	33	37	(1.0)	10.2
22	-	-	-	-
23	49	19	6.9	9.6
24	-	-	-	-
25	-	-	-	-
26	43	21	10.6	8.4
3/1/65	(142)	(104)	9.7	19.4
2	18	13	12.7	9.3
3	-	-	-	-
4	-	-	-	-
5	-	-	-	-
8	-	-	-	-
9	-	21	-	15.5
10	54	39	11.8	9.8
11	60	42	10.1	11.1
12	57	34	13.3	8.7
15	67	34	12.5	10.5
16	67	48	10.7	8.0
17	75	47	6.9	7.3
18	68	49	7.4	11.0
19	68	47	8.9	6.7
22	89	35	9.8	8.5
23	66	59	11.8	11.7
24	82	42	9.7	12.8
25	51	26	-	-
26	(236)	(130)	15.7	6.6
29	53	40	(24.1)	11.0
30	53	25	5.7	9.4
31	50	30	5.1	11.4
4/1/65	73	37	12.4	10.1
2	-	-	10.1	9.7
Average	55.8	34.2	10.0	10.8
Variance		- 39%		+ 8%

() Excluded from average

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SPECTROCHEMICAL ANALYSIS

Approximate Concentration - %

<u>Element</u>	<u>Bentonite</u>	<u>Liquid Alum</u>
Ag	< 0.01	0.0
Al	> 1.0	> 1.0
As	0.0	0.0
Au	0.0	0.0
B	.01 to 1.0	0.0
Ba	0.0	0.0
Be	< 0.01	0.0
Bi	0.0	0.0
C	-	-
Ca	.01 to 1.0	0.0
Cb	.01 to 1.0	0.0
Cd	0.0	0.0
Co	0.0	0.0
Cr	0.0	0.01
Cu	0.01	0.0
Fe	> 1.0	> 1.0
Hg	0.0	0.0
K	0.0	0.0
La	0.0	0.0
Li	0.0	0.0
Mg	> 1.0	< 0.01
Mn	.01 to 1.0	< 0.01
Mo	< 0.01	0.0
Na	.01 to 1.0	< 0.01
Ni	0.0	< 0.01
P	0.0	0.0
Pb	< 0.01	0.0
Sb	0.0	0.0
Si	> 1.0	< 0.01
Sn	< 0.01	0.0
Sr	0.0	0.0
Ta	0.0	0.0
Ti	< 0.01	0.01
U	0.0	0.0
V	0.0	< 0.01
Zn	0.0	0.0

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PRODUCTION TEST IP-740

H WATER PLANT OPERATING CHARACTERISTICS

Date	Raw Water		Alum - ppm			Coag Aid		pH				Filt H ₂ O		Backwash		Cl ₂ Res ppm	190 ppm Add.			
	Turb	Temp	Head House		C Well	E	W	Treated		Filtered		E	W	E	W		Ben.	Sep.		
			ppm	OC				E	W	E	W								E	W
2/15/65	26	5.0	15.2	16.2	0.5	.01	.018	7.0	6.66	6.66	6.66	.006	.006	6.0	6.0	.006	0	0		
16	22	5.0	15.2	16.1	1.0	.013	.018	7.01	6.64	6.64	6.64	.008	.006	6.0	6.0	.05	0	0		
17	25	5.3	15.2	16.7	1.5	.015	.018	7.03	6.64	6.65	6.64	.006	.006	6.0	6.0	.05	0	0		
18	21	5.4	15.2	15.7	2.0	.015	.018	6.99	6.62	6.65	6.62	.0065	.007	6.0	6.0	.05	1.0	0		
19	28	5.6	15.4	15.4	0	.015	.018	6.98	6.60	6.63	6.60	.006	.006	6.0	6.0	.05	0	0		
20	21	6.2	15.6	15.6	0	.015	.018	7.01	6.62	6.62	6.62	.0065	.007	6.0	6.0	.05	0	0		
21	30	5.7	15.5	15.3	0	.015	.018	7.03	6.63	6.61	6.63	.005	.005	6.0	6.0	.05	0	0		
22	25	5.6	15.4	15.3	0	.015	.018	7.01	6.63	6.63	6.63	.0055	.0055	6.0	6.0	.05	0	0		
23	24	5.3	15.4	15.2	2.0	.015	.018	7.01	6.62	6.62	6.62	.005	.006	6.0	6.0	.05	0.5	0		
24	Down				0				6.62	6.62	6.62					.07	0	0		
25	Down				0				6.62	6.65	6.69					.05	0	0		
26	24	5.8	15.3	15.1	0	.015	.018	6.98	6.64	6.60	6.64	.005	.005	6.0	6.0	.05	0	0		
27	23	6.2	15.3	15.3	2.0	.014	.018	7.01	6.63	6.62	6.63	.0055	.0055	6.0	6.0	.05	1.0	0		
28	24	5.5	15.4	15.4	2.0	.015	.018	7.03	6.60	6.60	6.60	.005	.005	6.0	6.0	.05	1.0	0		
3/1/65	24	5.4	15.4	15.3	2.0	.015	.018	7.03	6.63	6.62	6.63	.0055	.0055	6.0	6.0	.05	1.0	0		
2	23	5.0	15.3	14.1	4.0	.015	.018	7.02	6.65	6.63	6.65	.005	.005	6.0	6.0	.06	1.0	0		
3	Down				0				6.66	6.64	6.66					.08	0	0		
4	Down				0				6.69	6.67	6.69					.12	0	0		
5	Down				0				6.63	6.62	6.63					.07	0	0		
6	24	6.3	15.3	15.4	0	.015	.018	7.04	6.66	6.64	6.66	.005	.005	6.0	6.0	.05	0	0		
7	24	6.3	15.4	15.2	0	.015	.018	7.08	6.65	6.65	6.65	.005	.005	6.0	6.0	.08	0	0		
8	Down				0				6.65	6.63	6.65					.06	0	0		
9	Down				0				6.65	6.63	6.65					.06	0	0		
10	23	7.0	15.3	15.3	0	.015	.018	6.99	6.65	6.65	6.65	.005	.005	6.0	6.0	.07	0	0		
11	23	6.6	15.4	15.2	0	.015	.018	6.98	6.67	6.65	6.67	.005	.005	6.0	6.0	.06	0	0		
12	18	6.3	15.6	15.3	0	.015	.018	7.02	6.64	6.64	6.64	.005	.005	6.0	6.0	.05	0	0		
13	16	6.7	15.6	15.0	0	.015	.018	7.04	6.63	6.62	6.63	.006	.006	6.0	6.0	.05	0	0		
14	15	7.3	15.5	15.0	0	.015	.018	7.00	6.62	6.63	6.62	.006	.006	6.0	6.0	.05	0	0		
15	15	7.0	15.3	15.0	0	.015	.018	7.01	6.66	6.64	6.66	.007	.007	6.0	6.0	.06	0	0		

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Production Test IP-740 - H Water Plant Operating Characteristics (Continued)

Date	Raw Water		Alum - ppm			Coag Aid		pH		Filt H ₂ O		Backwash		Cl ₂		190 ppm	
	Turb	Temp	Head House		C Well	E	W	Treated	Filtered	E	W	E	W	Res	ppm	Ben.	Sep.
			E	W				E	W								
3/16/65	21	6.5	15.6	15.2	0	.015	.018	6.98	6.67	6.67	6.67	.006	.007	6.0	.06	0	0
17	17	6.5	15.4	15.3	0	.015	.020	6.99	6.67	6.67	6.67	.008	.007	6.0	.05	0	0
18	26	6.3	15.4	15.0	0	.023	.030	7.02	6.62	6.63	6.62	.008	.009	6.0	.05	0	0
19	25	5.8	15.8	15.0	0	.023	.030	7.04	6.65	6.64	6.65	.006	.007	6.0	.05	0	0
20	25	6.6	15.7	15.3	0	.023	.030	7.04	6.62	6.65	6.62	.008	.008	6.0	.05	0	0
21	27	6.6	15.6	15.3	0	.020	.025	7.00	6.62	6.62	6.62	.0065	.007	6.0	.05	0	0
22	31	7.1	15.7	15.1	0	.028	.030	6.99	6.64	6.62	6.64	.0065	.006	6.0	.05	1.0	0
23	34	6.3	15.2	15.1	0	.028	.030	6.97	6.63	6.61	6.63	.008	.007	6.0	.05	1.0	0
24	36	6.0	15.4	15.2	1.0	.028	.030	7.01	6.66	6.61	6.66	.007	.007	6.0	.05	1.0	0
25	38	6.3	15.0	15.3	1.0	.028	.030	7.00	6.64	6.64	6.64	.0065	.007	6.0	.05	1.0	0
26	35	6.0	15.7	15.2	1.0	.030	.034	7.01	6.66	6.65	6.66	.006	.006	6.0	.05	1.0	0
27	35	6.6	15.7	15.3	1.0	.028	.030	6.99	6.63	6.62	6.63	.006	.006	6.0	.05	1.0	0
28	35	6.6	15.7	15.3	1.0	.028	.030	6.98	6.63	6.63	6.63	.006	.007	6.0	.05	1.0	0
29	31	6.3	15.8	15.2	1.0	.028	.030	7.03	6.64	6.65	6.64	.006	.007	6.0	.05	1.0	0
30	26	6.3	15.7	15.2	1.0	.030	.034	7.02	6.62	6.65	6.62	.006	.006	6.0	.05	1.0	0
31	28	6.6	15.8	15.2	1.0	.030	.034	7.04	6.63	6.64	6.63	.006	.006	6.0	.05	1.0	0
4/1/65	26	6.8	15.7	15.3	1.0	.030	.034	6.98	6.62	6.63	6.62	.006	.006	6.0	.05	1.0	0
2	27	6.7	15.6	15.2	1.0	.003	.034	6.98	6.62	6.61	6.62	.0065	.007	6.0	.05	1.0	0
3	25	6.3	15.3	15.1	1.0	.003	.034	7.02	6.63	6.64	6.63	.005	.005	6.0	.05	1.0	0
4	Down				0												

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SCHEMATIC ARRANGEMENT
 BENTONITE INC.
 190-H
 PT -IP 740

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FABRICATE FUNNEL SCREEN FROM 16 MESH WIRE CLOTH
(2 REQUIRED)

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BENTONITE MIXING SCREEN

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SCHEMATIC ARRANGEMENT
SEPARAN INC.
190-H
FT-T.P 740

190 PUMP ROOM

190 TANK ROOM

SCHEMATIC ARRANGEMENT
SEPARAN SUPPLY
190-H
PT-IP 740

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SCHEMATIC ARRANGEMENT
ALUM ADDITION - WEST HILL
183 - H

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**DATE
FILMED**

8/16/94

END