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January 5, 1956

TO: C. W. Botsford, Head
Reactor Operations Engineering Unit
Process Sub-Section
REACTOR SECTION

SEPARAN FOR WATER TREATMENT

INTRODUCTION

Separan is a new water plant coagulant chemical which was submitted to the Process Sub-Section for evaluation in late 1954. Beaker tests were run which showed the material to be potentially valuable in modern water filter plants, but thorough evaluation was impossible because proper testing facilities were not available.

Since August, 1955, Process Sub-Section has operated an experimental filter plant which has shown promise as an evaluation tool. Consequently, as the facility appeared to be adequate for testing Separan, a trial run was made. The results have been so promising that an interim report was thought desirable. The results of our preliminary tests follow.

SUMMARY

Separan alone is an outstandingly good coagulant when the turbidity in the raw water exceeds 1,000 PPM. Unfortunately, when the turbidity of the raw water is in the range of 0 to 100 PPM, our normal values, Separan alone appears to be of no value as a coagulant. When Separan was used along with alum, however,

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SUMMARY (Cont'd)

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excellent results are obtained. Filter break-through was stopped with as little as 0.02 ppm Separan. The first approximation is that 0.02 ppm Separan is roughly equivalent to 4 ppm activated silica. In terms of cost Separan can probably be used for about 10 per cent of the cost of activated silica for an eventual Post CG-558 saving of over \$200,000 a year. It seems probable at this date that Separan will reduce the cost of water treatment sharply if it can be used. Perhaps of more interest, Separan appears to offer real promise of making it possible to operate filters at 10 gpm per square foot. Intermittent chemical feed, perhaps on a cycle of one hour out of each filter run appears to be a distinct possibility. The material has a tremendous advantage over activated silica in that no costly equipment is necessary for the preparation of the solution. Separan is dissolved in water and fed at a constant rate. Because the quantities of the material fed are so minute, storage problems will be reduced and equipment can be small. It is believed that the true significance of Separan as a water treatment chemical may have been missed at locations other than Hanford. It is believed that the experimental filter plant plus the light scattering microphotometer has allowed us to evaluate the potential benefits of this material much more adequately than has heretofore been possible. It is believed possible that Separan may revolutionize water treatment as people become generally aware of its merit.

Experience has shown that when filtered water turbidity is held below 0.005 ppm as measured by the light scattering microphotometer that the water does not cause film in the reactor process tubes. Experience also has shown that water plant results, including filtered water turbidity, obtained from the experimental plant correlate almost perfectly with results obtained from the production plants. As the filtered water turbidity obtained in the experimental plant while using Separan was easily maintained below 0.005 ppm it is highly probable that Separan treated water from the production plants will not cause film growth in the reactor tubes. One cannot be sure that Separan will work perfectly at Hanford until water treated with the material is passed through process tubes. Consequently, it is recommended that immediate action be taken to use Separan treated water for process tube cooling either at 1706-KE or in one of the other areas as a half pile test.

DISCUSSION

Separan is an organic chemical developed and sold by the Dow Chemical Company. The material was developed for use in the mining industry but the material was so outstandingly good as a coagulant that some people thought that it might possibly be used for water treatment. An article in "Chemical and Engineering News" was seen by T. W. Hauff of the Manufacturing Department and was sent to Process as an item of interest. A laboratory sample of the material was obtained and a few beaker tests were run in 1954. The beaker tests showed that the material was very good as a coagulant when the turbidity in the water sample was over 1,000 ppm. Efforts to make the material work as a coagulant in our usual raw water where the turbidity was about 10 ppm were unsuccessful. A few beaker tests showed that Separan was of some value as a coagulant aid with alum. However, laboratory methods of evaluation were inadequate and a true estimate of the value of the material was impossible. Consequently tests were stopped until better testing methods could be devised.

In August, 1955, the Process Sub-Section started operation of an experimental filter plant. Tests run with alum and activated silica under various conditions were highly successful in that results obtained in the experimental filter plant were identical with results obtained in the large production plants. As the experimental plant was proven to be adequate for a preliminary evaluation of Separan, a few runs were planned. The first run was with one

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DISCUSSION (Cont'd)

ppm Separan, and 13 ppm alum on December 9, 1955. It will be noted that the Separan gave outstandingly good results (See Table I). A comparative control run was made using no Separan but 13 parts of alum which showed that abnormally good results were still being obtained on the filter (See Table II). At the same time the large plant filters were performing normally. The experimental filters were repeatedly backwashed, run with alum treated water and yet results obtained from the filters were still abnormally good. It was theorized that Separan might have coated the filters in some manner and so caused the filters to give better results than normally. Separan was used alone at a dose rate of 1 ppm through one test run. The results obtained were poor and are shown in Table IV. However, repeat runs using alum alone without any Separan gave outstandingly good results. This is an additional indication that the Separan had in some manner conditioned the sand so that results obtained with the alum were abnormally good. The effect existed for several filter washes (See Table II).

In order to test this conclusion modifications to the filter plant were made so that parallel experiments could be run, with Separan treated water going to one filter and alum treated water going to another. This parallel experiment showed that 0.33 ppm of Separan along with 13 ppm of alum did an outstandingly good job in preventing filter break-through. The control filter with 13 ppm of alum showed the normal water quality. The headloss build-up with the 0.33 ppm of Separan was very high. Past experience has shown that when head loss build-up is high, filter break-through is not a problem, because rapid rate of head loss build-up means that the floc is strong, and will not break up and go through the filter. Activated silica works in this same manner. The proper amount of Separan must be fed to stop the break-through and yet not cause excessive head loss build up. Again, this is the same problem which exists with activated silica. The data are shown in Table IV.

A test run was made with Separan being added to alum treated water at the entrance to a settling basin and at the entrance to a filter. One test filter received alum treated water, a second filter received alum water with 0.1 ppm Separan added in the settling basin while a third filter received alum treated water with 0.1 ppm Separan added at the filter. The Separan gave excellent water quality when added either in the settling basin or in the filter. In contrast the control filter without Separan gave the usual poor water quality. The head loss increase with 0.1 ppm Separan was excessive but considerably less than when 0.33 ppm Separan was fed. The data are shown in Table V.

A test run was made with 0.02 ppm Separan being added at the same location as in the preceding test. The Separan again gave excellent water quality while the control filter gave the usual poor water quality. Head loss increase with 0.02 ppm Separan was still higher than normal but much less than with 0.1 ppm of Separan. These data which indicate that considerably less than 0.02 ppm Separan is sufficient, are shown in Table VI. Separan in concentrations below 0.02 ppm will be used in future test runs.

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DISCUSSION (Cont'd)

In all of the test runs with Separan there were no visible changes in the appearance of the treated water. This is highly significant because almost all water treatment plants use the appearance of the floc or treated water as a criteria of the adequacy of treatment. At Hanford we do not ordinarily pay too much attention to the appearance of the floc because results obtained with the microphotometer are far more reliable. It is then concluded that people at other plants will probably have no way of knowing how good Separan is. It will probably require such large amounts to get visibly good coagulation that the cost will be prohibitively high except under unusual conditions. At Hanford we can evaluate the beneficial results obtained by use of the material because the microphotometer will allow us to carefully follow results obtained when very small amounts of Separan are used. Our production of filtered water after completion of Project CG-558, will be about 6 gpm per square foot of filter surface. Additional increases in water flow are limited by inadequacy in settling time and the resulting very short filter runs. Activated silica makes it possible to run at six gpm per square foot but a better chemical might allow even higher rates. Separan shows considerable promise of allowing us to go beyond six gpm per square foot. Most of our test runs on the small filters have been at a rate of ten gpm per square foot. There is every indication that this rate is practical if the hydraulics of the system will allow it. In fact, even ten gpm per square foot might be conservative. It has not been the filtration rate, but the ability to adequately pre-condition the water with very short flocculation and settling time, which has limited water throughput. Separan offers hope that we can properly condition the water and thus run at ten or more gpm per square foot. Of course, hydraulic changes in the filter effluent piping would probably be necessary. We do not know whether or not such large quantities of water may be necessary, but past history has shown that it is difficult to reach a saturation point on the amount of water desired. It is probable that if we can produce the water economically, that it will be used.

Complete information as to the amount of Separan to be used, along with the amount of alum, points of chemical addition, etc., involve considerable testing work. It will be several weeks before fairly complete information concerning all the facts of the use of this material will be obtained. Even after this, of course, changes in the nature of the water will require additional testing before complete information is obtained. It is believed that after a few weeks of testing that enough will be known about the material to warrant in-pile testing. In-pile information cannot be obtained from our own experimental facility, on the other hand, it would seem rather inappropriate to attempt to get in-pile data until thorough out of pile testing is complete.

It will be remembered that the 1706-KE water testing facility is supplied from water being produced by the KE production plant. It will be difficult to get good quick results from this large scale plant test. The equipment provided for production in the KE filter plant is not readily suited for experimental use and if there are undisclosed flaws in the use of the Separan, the K Pile will suffer. Many of these possible undisclosed flaws should be detected in our own experimental filter plant. It is unfortunate that the 1706-KE facility does not have complete water treatment facilities. However, it can be a very useful evaluation facility because water from the test filter can be pumped through the reactor. After Separan has been used successfully in the 1706-KE

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DISCUSSION (Cont'd)

facility, a full scale plant test will be in order. After thorough evaluation in one area the Separan, if successful can then be used in all areas.

The impact of Separan on the design and construction of a modern filter plant may well be terrific. It seems possible or even probable that Separan may make it possible to shorten the mixing, flocculation and settling time and increase the filtration rate well beyond anything that has been attempted before. As water treatment plants and capital costs are large, cost savings will be significant.

Other organic coagulants probably similar to Separan and perhaps identical are now on the market. One of these materials is sold by the Illinois Water Treatment Company and is called Floxell. Laboratory tests run with a small sample submitted by J. E. Kaveckis showed the material to be similar to Separan. National Aluminate Company markets a product called Nalco 600. Technical descriptions of the material indicate that it is very similar to Separan. Tests on both of these materials are planned.

The nature of the work involved in successfully applying Separan to Hanford use is such that no one group can resolve the questions quickly because no one group has all of the facilities required for intelligent development of this material. There is reason to believe that cooperative efforts by Process and Pile Technology personnel will result in successful application of Separan as a water treatment chemical at Hanford with resulting benefits to the Hanford Works.

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TABLE I

THE EFFECT OF SEPARAN (AS A COAGULANT AID WITH ALUM) ON WATER QUALITY

<u>Time Since Backwash</u>	<u>Alum PPM</u>	<u>Silica PPM</u>	<u>Separan PPM</u>	<u>Water Turbidity PPM</u>	<u>Filter Rate GPM sq. ft.</u>
1/4	13	1	0	.004	10.0
1/2	13	1	0	.005	10.0
1	13	1	0	.007	10.0
2	13	1	0	.010	10.0
3	13	1	0	.013	10.0
1/2	13	3	0	.005	10.0
1	13	3	0	.007	10.0
2	13	3	0	.010	10.0
3	13	3	0	.011	10.0
1/2	13	0	0	.009	10.0
1-1/4	13	0	0	.011	10.0
1/2	13	0	1	.003	10.0
3/4	13	0	1	.003	10.0
1	13	0	1	.003	10.0
1-1/4	13	0	1	.003	10.0
1-1/2	13	0	1	.003	10.0
1-3/4	13	0	1	.003	10.0
2	13	0	1	.003	10.0
2-1/4	13	0	0	.003	10.0

NOTE: Separan was injected just ahead of flash mixers.

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TABLE II

LAG EFFECT OF SEPARAN ON WATER QUALITY

First and Second Day After Feeding Separan
(1 PPM) Along With Alum (13 PPM)

<u>Time Since</u> <u>Backwash</u> <u>HOURS</u>	<u>Alum</u> <u>PPM</u>	<u>Silica</u> <u>PPM</u>	<u>Separan</u> <u>PPM</u>	<u>Water Turbidity</u> <u>PPM</u>	<u>Filtration Rate</u> <u>GPM sq. ft.</u>
1/2	13	0	0	.005	10.0
1	13	0	0	.005	10.0
1-1/2	13	0	0	.007	10.0
2-1/3	13	0	0	.009	10.0
1/2	13	0	0	.006	10.0
1	13	0	0	.005	10.0
1-1/2	13	0	0	.006	10.0
2	13	0	0	.008	10.0

First Day After Feeding Separan Alone (1 PPM)

1/2	13	0	0	.005	10.0
1	13	0	0	.003	10.0
2-1/3	13	0	0	.003	10.0
4-1/3	13	0	0	.012	10.0

NOTE: Table I shows normal two hour reading to be 0.014 even when 1-3 PPM of silica are being fed. In contrast note the .009, .008 and .003 readings on above filter after Separan had been fed.

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TABLE III

THE EFFECT OF SEPARAN ALONE ON WATER QUALITY

Time Since Backwash HOURS	Alum PPM	Separan PPM	Water Turbidity PPM			Filtration Rate GPM per sq. ft.		
			#2	#3	#4	#2	#3	#4
1/2	0	1	.015	.012	.018	4.1	5.8	10.0
3/4	0	1	.022	.016	.016	4.1	5.8	10.0
1-3/4	0	1	.020	.019	.022	4.1	5.8	10.0
2	0	1	.022	.022	.022	4.1	5.8	10.0

NOTE: Separan was injected just ahead of flash mixers.

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PARALLEL EXPERIMENT SHOWING THE EFFECT OF SEPARAN AS A COAGULANT AID

Alum - 13 PPM
Silica - 0 PPM

Filtration Rate - 10 GPM per sq. ft. (both filters)

Settling basin split into two sections. Separan was fed as noted to section one while section two did not receive Separan.

Time Since Backwash Hours	Separan Basin #2 Filter				Alum Basin #1 Filter			
	Alum PPM	Separan PPM	Cumulative Headloss Cm Hg	Turbidity PPM	Alum PPM	Separan PPM	Cumulative Headloss Cm Hg	Turbidity PPM
1/2	13	0	-	.012	13	0	-	.006
1	13	0	0.4	.012	13	0	0.3	.005
1-1/2	13	0	0.6	.008	13	0	0.5	.005
2	13	0	-	.008	13	0	-	.008
2-1/2	13	0	0.6	.008	13	0	0.8	.012
3	13	0	0.8	.009	13	0	1.0	.017
3-1/2	13	0.33	0.9	.006	13	0	1.1	.020
4	13	0.33	1.6	.004	13	0	1.3	.026
4-1/2	13	0.33	3.1	.004	13	0	1.4	.029
0	13	0.33	0.0	-	13	0	0.0	-
1/4	13	0.33	0.3	.005	13	0	0.1	.004
1	13	0.33	2.3	.004	13	0	0.4	.009

NOTE: Separan injected at entrance to settling basin rather than ahead of flash mixers.

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TABLE V

PARALLEL EXPERIMENT SHOWING THE EFFECT OF SEPARAN WHEN INJECTED IN SETTLING BASIN AND IN FILTER

Conditions:

Alum - 13 PPM to both basins
 Separan to 1st basin inlet but none to 2nd basin
 Separan injected directly into filter #3 as indicated
 Filtration Rate - 10 GPM per sq. ft. on all filters

Time Since Backwash #	SEPARAN BASIN #2 FILTER				#3 FILTER				ALUM BASIN #3 AND #4 FILTERS			
	Separan PPM	Cumulative Headloss Cm Hg	Turbidity PPM		Separan PPM	Cumulative Headloss Cm Hg	Turbidity PPM		Separan PPM	Cumulative Headloss Cm Hg	Turbidity PPM	
1/2	0.1	0.0	.004		0	0.0	.002		0	0.0	.002	
1	0.1	1.0	.004		0	0.2	.003		0	0.2	.004	
1-1/2	0.1	2.1	.003		0	0.5	.003		0	0.3	.006	
2	0.1	3.1	.003		0	0.8	.008		0	0.4	.008	
2-1/2	0.1	3.8	.003		0	1.1	.015		0	0.7	.020	
1/2	0.1	0.0	.004		0.1	0.0	.002		0	0.0	.004	
1	0.1	1.3	.004		0.1	0.7	.004		0	0.1	.004	
1-1/2	0.1	2.3	.004		0.1	1.3	.004		0	0.2	.012	
2	0.1	3.3	.003		0.1	2.2	.002		0	0.5	.017	
2-1/2	0.1	4.0	.003		0.1	3.0	.002		0	0.6	.022	
3	0.1	4.5	.003		0.1	4.4	.002		0	0.8	.027	
3-1/2	0.1	4.8	.003		0.1	5.7	.002		0	1.0	.032	
4	0.1	4.8	.003		0.1	6.7	.002		0	1.1	.040	

* NOTE: Filter essentially plugged - flow down to 1-3 GPM per sq. ft.

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TABLE VITHE EFFECT OF 0.02 PPM SEPARAN ON WATER QUALITYConditions:

Alum - 1 1/2 PPM to all Filters
 Separan to Settling Basin Feeding #2 Filter
 Separan Directly to #3 Filter
 Filtration Rate - 10 GPM per sq. ft.

Hours on Line	ALUM ALONE #4 FILTER			SEPARAN TO FILTER #3			SEPARAN TO BASIN - FILTER #2		
	Cumulative Headloss Cm Hg	Turbidity PPM		Cumulative Headloss Cm Hg	Turbidity PPM		Cumulative Headloss Cm Hg	Turbidity PPM	
1/2	0.2	.003		0.2	.002		-	.003	
1	0.3	.005		0.5	.002		0.6	.003	
1-1/2	0.5	.008		0.8	.002		0.9	.003	
2	0.6	.016		1.3	.002		1.2	.003	
2-1/2	0.7	.021		1.9	.002		1.5	.003	
3	0.9	.028		2.6	.002		1.9	.004	
3-1/2	1.0	.030		3.3	.002		2.0	.004	
4	1.1	.035		3.8	.002		2.1	.005	
4-1/2	1.2	.038		4.5	.002		2.2	.007	
5	1.3	.042		4.9	.002		2.3	.008	
5-1/2	1.4	.042		5.1	.002		2.4	.009	

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