Serial No. KN-71-15

Copy No. 18

E. I. DU PONT DE NEMOURS & COMPANY
256 VANDERPOOL STREET
NEWARK, NEW JERSEY

KN-71-15 Copy 18 of 18

NEWARK PLANT
PIGMENT COLOR RESEARCH REPORT

OPTIMIZATION OF ANNUAL FILTER AID COST

Period Covered APRIL - MAY 1971

FILE: 114

DATE: 6/29/71

NJ 14971

KN 71-15

Copy No. 18

1. Numerical File
2. Research Office File - 114
3. Newark Library File - 114
4. M.Hunt, Pigments, Wilmington
5. W.S.Struve/J.Jackson/A.R.Hanke
6. R.H.Wetzel, Newport (Circ. and file)
7. E.E.Jaffe/E.F.Klenke/B.H.Perkins/Library
8. P.J.Monahan, Newark (Vital Records)
9. N.G.Fisher, Central Research Dept., Wilmington
10. Newark Library - for Central Report Index
11. Newark Library - for Central Report Index
12. R.H.Akins/W.J.McClure
13. R.B.Morton/R.Gedd
14. S.L.Ritchey
15. Extra
16. Extra
17. Extra
18. Extra
19. Extra

NEWARK PLANT

PIGMENT COLOR RESEARCH REPORT

TITLE: OPTIMIZATION OF ANNUAL FILTER AID COST

PERIOD COVERED: APRIL - MAY 1971

SUBMITTED BY: S. L. RITCHEY Date Submitted: 6/21/71

APPROVED BY: E. F. KLENKE, JR. Date Released: 6/29/71

ABSTRACT:

Some grade of filter aid will be required in the operation of the Newark liquid waste treatment plant. A laboratory study was made of fifteen candidates to determine which offered the lowest operating cost. "Celite 545," the filter aid used in the evaluation of the "MATZ" filter, was included. The lowest cost filter aid of those tested was Grefco, Inc. "Perlite" product, "CP-150." Assuming the liquid waste samples used in this study represented what will ultimately be processed, use of "CP-150" will result in a filter aid materials cost of about $126,000 per year, a saving of about $62,000 per year over "Celite 545."

TABLE OF CONTENTS

INTRODUCTION

A liquid waste treatment facility is being built at the Newark plant which will employ four "MATZ" micro solids separators. These units can operate with various grades of commercial filter aids. Johns-Manville "Celite 545" diatomacious earth was employed exclusively in a four month test program using a full sized separator. This study was undertaken to evaluate fifteen grades of filter aids to determine which has the lowest operating cost, or value in use. Throughout the study, consistent operating conditions were used to make the results comparable. These conditions were similar to the optimum conditions determined in the evaluation of the full sized separator.

SUMMARY AND CONCLUSIONS

From this investigation, the following conclusions can be drawn.

1. Of the fifteen filter aid products tested Grefco's "Perlite" product, "CP-150" offers the lowest annual operating cost. Use of "CP-150" will incur a filter aid materials cost of $126,000 per year. "CP-150" should be thoroughly plant tested for operating feasibility, because of the potential cost savings of $61,800/year over "Celite 545." However, "Celite 545" should be used in plant start-up, as it has been proven adequate in previous plant tests.

2. The Grefco products, "CP-150," "CP-175" and "Speedplus" should be evaluated to determine if the optimum operating conditions for each are the same as for "Celite 545."

3. Georgia-Kaolin Company product "Hydrite MP," and the grade of bituminous coal BX 28 will not act as acceptable filter aids.

4. Widely varying data using "Celite 503" were inconclusive, and an operating cost was not calculated.

PATENT STATUS

No patent action will be taken as a result of this study.

DISCUSSION

Objective

A liquid waste treatment facility is being built at the Newark plant to reduce the solids' concentration and heavy metal concentration in the plant effluent. A battery of four "MATZ" 350 gallon per minute filters will be used to separate sewage solids. Three of these will be operational, with one an installed spare. The filters ("MATZ" micro solids separators) operate by coating the filter screens with a filter aid on a specified cycle, then pumping sewage through the coated screens. The sewage is filtered until a differential pressure of 50-60 psig exists across the screens. At this point the filter cycle is terminated, and the screens are shaken for a specified time. The filter aid coating (precoat) cycle is then begun again.

To aid filtration, filter aid as body feed is added to the sewage continuously on a ratio to solids before the sewage encounters the filter screens.

A full size filter was tested for four months. Using a Johns-Manville diatomacious earth filter aid, "Celite 545," an average filter cycle time of 20 minutes was observed. This result came from using plant sewage of widely varying solids concentrations, the average concentration being about 1500 ppm. A total of seven minutes per cycle was required to complete the precoating and shaking operations.

Other filter aid products are available which will adequately filter the plant sewage. Each has a unique value in use, e.g., cost per cycle vs. cycle length. The purpose of the laboratory work

covered in this report was to evaluate fifteen filter aid products, including "Celite 545," to determine which would give the lowest operating cost, or value in use.

The filter aids tested were:

Johns-Manville diatomacious earth products -

"Celite 545"

"Celite 560"

"Celite 501"

"Hyflo Supercel"

"Standard Superçel"

"Celite 503"

Grefco diatomacious earth product

"Speedplus"

Eagle-Picher Industries diatomacious earth products

"FW-50"

"FW-60"

Grefco "Perlite" products

"CP-175"

"CP-150"

"4156"

"BW-40" cellulose fiber product

Georgia-Kaolin product

"Hydrite MP"

BX 28 grade of bituminous coal

Description of Experiment

A Johns-Manville pressure filter was used in the laboratory to simulate the micro solids separator. The laboratory filter consisted of a circular, vertical filter plate, 1.0 ft^2 in area. The filter plate was housed in a transparent pressure cell. Flow rate and differential pressure could be read directly from a rotameter and gauge on the filter cell body.

Two agitated tanks were provided for precoat solution and sewage solution. A three-way valve setup allowed easy switching from one tank to the other. The effluent, except for periodic samples, was ditched.

Sewage collected from the plant was analyzed for solids concentration, then adjusted to 1500 ppm for each run. Body feed was added to the feed tank at 0.2 pounds of filter aid per pound of solids, prior to filtration of the sewage.

A precoat slurry was made up at an arbitrary concentration to deposit 0.1 pound filter aid per square foot of filter area on the filter screen. This was accomplished by recirculating the precoat slurry until all the filter aid was deposited on the screen.

Once the filter was properly precoated, filtration was begun. Pressure and time were recorded at one minute intervals. These data form the results shown in Exhibit A. All runs were made at a feed rate of one gallon per minute. After each run the screen was thoroughly washed, so the initial pressure drop across the filter was due only to that of the screen and precoat cake.

Data Collection and Treatment

During collection of the data characterizing each type of filter aid it became apparent that not all results would be directly

comparable due to differences in the sewage. As can be seen in Exhibit A, the pressure-time relationship for the same filter aid using different sewage samples is markedly different. To compensate for this, "Celite 545" was used with each sewage sample as a control.

Effluent solids concentration was not correlated with filter aid type or filter cycle time. One constraint of the sewage plant operation is the required effluent concentration of 400 ppm or below. All runs made in this investigation were far enough below this level that no effort was made to characterize filter aid types with this variable.

No effort was made to evaluate different levels of precoat quantity or body feed concentration for a given filter aid type. A few runs (Exhibit A) were made with "Celite 545" to substantiate optimum operating conditions resulting from the tests with the full-sized separator. A precoat quantity of 0.1 pound filter aid per square foot of filter surface and body feed concentration of 0.2 pound filter aid per pound feed solids concentration were picked as generally optimum conditions. However, these are the best conditions for using "Celite 545." This may or may not be true for other filter aid types. If not, of course, the relative operating costs for the different filter aid types could be altered. This question should be investigated with the three filter aids which have the lowest operating costs based on this investigation.

One limitation of the test apparatus was the inability to reach a differential pressure of 50 psig across the filter screen and cake. To compensate for this, the data from each run were plotted as logarithm of differential pressure (psig) vs. logarithm of the filter cycle time (minutes). This assumes a relationship of:

$$\text{Filter Time} = A\ (\text{Differential Pressure})^{B}$$

A, B, constants.

This is consistent with theory for this type of filtration.* The data from each run, plotted in this manner, gave a linear relationship, which was extrapolated to 50 psig differential pressure. The filter cycle time at 50 psig is the data which appears in Exhibit A.

The calculation of operating cost of each filter aid was based on the experience gained in the tests of the full-size separator. Three separators were assumed to operate on a 27 minute cycle (20 minutes filtering, seven minutes in other operations) treating a feed of 1500 ppm solids at 350 gallons per minute (per separator) using "Celite 545" as a filter aid. Each separator has 344 square feet of filter surface which requires a precoat of 0.1 pound of filter aid per square foot of filter area. Body feed is added to the feed at 0.2 pound of filter aid per pound of solids in the feed.

The data of Exhibit A indicate the per cent increase or decrease in filter cycle to be expected from each filter aid type relative to "Celite 545." From this the filtering time per operating hour and number of precoat cycles per operating hour were calculated for each filter aid. It was assumed that the filters would operate continuously throughout the year.

A price list including freight costs for each filter aid appears in Exhibit B. Using these and the annual filter aid volume per year calculated as described above, the operating costs per year were determined. These results appear below in order of increasing cost.

*Tiller, Frank M., "Filtration Theory Today," Chemical Engineering June 20, 1966.

ANNUAL FILTER AID COST

Filter aid	Annual Cost ($M/Yr)
"CP-150"	126.0
"Speedplus"	131.9
"CP-175"	134.0
"4156"	148.5
"FW-50"	150.0
"Celite 501"	152.2
"FW-60"	154.0
"Standard Supercel"	154.2
"Hyflo Supercel	162.0
"Celite 545"	187.8
"Celite 560"	275.4
"BW-40"	525.2
"Celite 503"	Data inconclusive
"Hydrite MP"	Not feasible for use
BX 28	Not feasible for use

RESULTS AND CONCLUSIONS

From this investigation, the following conclusions can be drawn:

1. Of the fifteen filter aid products tested, Grefco "Perlite" product, "CP-150," offers the lowest annual operating cost. Use of "CP-150" will incur a filter aid materials cost of about $126,000/yr. "CP-150" should be thoroughly plant tested for operating feasibility because of the potential cost savings of about $61,800/yr. over "Celite 545." However, "Celite 545" should be used in plant start-up, as it has been proven adequate in previous plant tests.
2. The Grefco products - "CP-150," "CP-175" and "Speedplus" should be evaluated to determine if the optimum operating conditions for each are the same as for "Celite 545."

3. Georgia-Kaolin product "Hydrite MP" and the grade of bituminous coal BX 28 will not act as acceptable filter aids.
4. Widely varying data using "Celite 503" were inconclusive, and an operating cost was not calculated.

EXHIBIT A

TEST RESULTS

Run	Filter Aid	Body Feed Ratio (lbs.Filter aid/ lbs.solids)	Precoat (lbs.filter aid/ft^2 filter area)	Feed Solids Conc. (ppm)	Filter Cycle Time (min.)	Sewage Sample	Sewage Solids Conc. (ppm)
1	Equipment testing run - no data taken						
2	Celite 545	0.1	0.15	3910	8.4	-	-
3	"	0.1	0.20	3910	Poor flow control	-	-
4	"	0.1	0.10	1500	7.3	-	-
5	"	0.1	0.05	1500	7.4	-	-
6	"	0.15	0.10	1500	7.8	-	-
7	BX 28 Coal	0.15	0.10	1500	Would not adequately precoat filter	-	-
8	Celite 545	0.2	0.1	1500	29.	#1	1,300
9	CP-150	0.2	0.1	1500	148.	#2	3,925
10	Speedplus	0.2	0.1	1500	500. $\pm$ 80	#3	12,320
11	Speedplus	0.2	0.1	1500	560 $\pm$ 50	#3	12,320
12	Celite 545	0.2	0.1	1500	370 $\pm$ 30	#3	12,320
13	Celite 503	0.2	0.1	1500	60	#4	8,010
14	Standard Supercel	0.2	0.1	1500	43	#4	8,010
15	Celite 545	0.2	0.1 (poor control in flow)	1500	45	#4	8,010

Exhibit A Test Results (Cont'd)

Run	Filter Aid	Body Feed Ratio (lbs.Filter aid/ lbs.Solids)	Precoat (lbs.filter aid/ft² filter area)	Feed Solids Conc. (ppm)	Filter Cycle Time(min.)	Sewage Sample	Sewage Solids Conc. (ppm)
16	Celite 545	0.2	0.1	1500	34	#4	8,010
17	Standard SC	0.2	0.1	1500	34	#4	8,010
18	BW-40	0.2	0.1	1500	35	#4	8,010
19	BW-40	0.2	0.1	1500	30 ± 5	#4	8,010
20	FW-60	0.2	0.1	1500	180	#5	9,010
21	Celite 545	0.2	0.1	1500	120	#5	9,010
22	FW-50	0.2	0.1	1500	175±25	#5	9,010
23	Hydrite	This material would not precoat.					
24	Celite 545	0.2	0.1	1500	38	#6	4,967
25	CP-150	0.2	0.1	1500	38 ± 3	#6	4,967
26	Speedplus	0,2	0.1	1500	56	#6	4,967
27	CP-175	0.2	0.1	1500	42 ± 5	#6	4,967
28	4156	0.2	0.1	1500	40 ± 3	#6	4,967
29	Celite 545	0.2	0.1	1500	350 ± 50	#7	9,210
30	Celite 545	0.2	0.1	1500	900 ± 100	#8	6,017
31	Standard SC	0.2	0.1	1500	590 ± 150	#8	6,017

Exhibit A Test Results (Cont'd)

Run	Filter Aid	Body Feed Ratio (lbs.Filter aid/ lbs. Solids)	Precoat (lbs.filter aid/ft² filter area)	Feed Solids Conc. (ppm)	Filter Cycle Time(min.)	Sewage Sample	Sewage Solids Conc. (ppm)
32	Celite 503	0.2	0.1	1500	400 ± 100	#8	6,017
33	Celite 560	0.2	0.1	1500	170 ± 30	#7	9,210
34	Hyflo SC	0.2	0.1	1500	310	#7	9,210
35	Celit3 501	0.2	0.1	1500	290	#7	9,210

EXHIBIT B

FILTER AID PRICES

Manufacturer	Filter Aid	Price ($/Ton)	Freight* ($/Ton)	Total ($/Ton)
Grefco, Inc.	Speedplus	68.00	33.20	101.20
	CP-150	66.00	12.60	78.60
	CP-175	71.00	12.60	83.60
	4156	80.00	12.60	92.60
	BW-40	315.00	12.60	327.60
Johns-Manville	Celite 545	84.00	33.20	117.20
	Celite 560	100.00	33.20	133.20
	Celite 501	73.00	33.20	106.20
	Standard Supercel	63.00	33.20	96.20
	Hyflo Supercel	68.00	33.20	101.20
Eagle-Picher	FW-60	84.00	33.20	117.20
	FW-50	82.00	33.20	115.20

*60M# carload lots