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This report is: [X] INTERIM [ ] FINAL and mainly: [X] NEW [ ] REVIEW

DESCRIPTIVE SUMMARY WITH CONCLUSIONS: (Include in this space references to data books, and to earlier related reports, patents and publications.)

SUMMARY

Pilot scale testing and lab testing showed that flocculation and settling of cell effluent streams is possible, but both indicated that filtration of the overflow would be required. XD 7338 was the most effective flocculant with an optimum dosage of ~ 3 ppm. Using XD 7338 as the flocculant with a 0.25 gpm/ft^2 clarifier feed rate gave an overflow clarity as low as ~ 7 Ftu turbidity, 0.3 ppm asbestos, and 1 ppm Fe. This data and "bomb" filtration data indicated that the amount of filter aid required could be reduced substantially (~ 1/2 that required for evaporator feed cell effluent and to ~ 1/3 for trench liquor); however, the flocculant costs using XD 7338 or its ~ equivalent (Allied Percol 511) would offset the filter aid cost reduction. Using Purifloc A-23 as the flocculant would be more economical, but the combined flocculant costs, filter aid costs, and increased capital costs would still be close to the filter aid costs for pressure leaf filtration only.

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CONCLUSIONS

1. Flocculation and settling of cell effluent streams was shown to be possible by lab testing and pilot scale testing, but filtration of the clarifier overflow would be required to obtain acceptable clarity.

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2. XD 7338 was a more effective flocculant than Purifloc A-23 in giving lower asbestos, iron, and turbidity concentrations, and XD 7338 was less sensitive to the stream temperature or NaOCl concentration.

3. The optimum flocculant dosage for XD 7338 or Purifloc A-23 was ~ 3 ppm.

4. The pilot scale testing indicated that brine treating sludge should not be used above ~ 100 ppm.

5. The design rate for a clarifier was ~ 0.25 gpm/ft^2 which would require ~ 125' diameter clarifier for the 3000 gpm evaporator feed and ~ 100' diameter clarifier for the 2000 gpm trench liquor stream.

6. In the pilot scale testing using XD 7338 at a 0.25 gpm/ft^2 feed rates, the overflow clarity averaged 12 FTu turbidity, 1.8 ppm Fe, and 1.08 ppm asbestos. This was ~ 80% asbestos removal, ~ 40% iron removal, and ~ 54% turbidity reduction.

7. The overflow clarity and lab "bomb" filter tests indicated that the amount of filter aid required for pressure leaf filtration could be cut in half for evaporator feed filtration and cut to ~ one third for trench liquor.

8. The flocculant costs for using XD 7338 would more than offset the filter aid cost reduction, but using Purifloc A-23 would slightly reduce the total operating costs versus pressure leaf filtration only.

9. Filtration of the clarifier underflow using a lab vacuum leaf filter to simulate a rotary drum vacuum filter showed that filtration rates of ~ 0.1 gpm/ft^2 would be obtained using DIC 476 as the precoat for a feed stream of ~ 12% wt solids.

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INTRODUCTION

This work was a continuation of other Louisiana Division testing on asbestos removal reported by LAD 321, Part 2, Trench Liquor Filtration; and Part 3, Evaporator Feed Filtration. This testing was used in the recommendation of the asbestos removal system for the Louisiana Division reported as Part 5. The purpose of this testing was to determine if the high filter aid costs for pressure leaf filtration could be reduced by flocculation and settling. Work done by Al Potoff of the Midland Division reported by EMR-LR-122 had shown that flocculation and settling was feasible in lab testing. That testing also indicated that the asbestos removal obtained by filtering the flocculated stream would be to concentrations as low as 0.001 ppm. Pilot scale testing was needed to confirm the results of the lab testing and to determine the size clarifiers needed. The Louisiana Division pilot scale testing can be compared to pilot scale testing done by the Midland Division when that work has been completed.

EXPERIMENTAL PROCEDURES AND EQUIPMENT

I. Lab Testing - Flocculation and settling tests, vacuum leaf filtration to simulate a rotary drum vacuum filter, and "bomb" pressure leaf filtration tests were conducted.

A. Flocculation and Settling Tests - The equipment used for these tests were 1000 ml graduated cylinders, magnetic stirreres, stop watches, and hot plates. The procedure used varied slightly depending on the variables being studied.

1) Usual Test Procedure - The graduated cylinders were filled with trench liquor or cell effluent and agitated to prevent settling. Crystals of $Na_2S_2O_3$ were then added to neutralize NaOCl for most of the testing. The testing was normally performed at $\sim$ 65°C. A settling agent (brine treating sludge) was then added, and the liquid was stirred vigorously for 2 minutes. The flocculant solution was then added with slow stirring and given 15 minutes contact time for flocculation to occur. At the end of that time, the stirring was stopped, and the solids were allowed to settle. During the settling step, samples were taken at periodic time intervals of $\sim$ 15 minutes and saved for analysis. The samples were analyzed for ppm Fe and turbidity by standard analytical methods. Some samples were selected for asbestos analysis by the A. A. Method.

2) Modified Procedures - The usual procedure was modified at various times to determine the effects of other variables.

Temp - The temperature used for testing was varied to determine the sensitivity of the different flocculants.

Agitation - The type and degree of agitation was varied during the 15 minutes flocculation step to determine the sensitivity of the flocks formed. A 3-bladed turbine and a magnetic stirring bar were used in the testing.

Hindered Settling - Pilot scale testing results did not give clarity as good as predicted by the lab testing. The slight agitation experienced in the pilot clarifier was suspected as one cause. To evaluate this possibility, the slowest possible agitation with a magnetic stirrer was used in the lab testing during the settling step.

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B. Lab Vacuum Leaf Filter - The apparatus used in this testing was the same as described by LAD-321 and is shown by Figure 1. The general procedure used in testing and sampling is also described in LAD-321. For this testing the use of various types of precoats and cloths were evaluated for filtering the pilot clarifier sludge or sluice material from the pressure leaf filters. The majority of this testing was done simulating a 3 min/rev drum speed.

C. Lab "Bomb" Pressure Leaf Filter - This equipment and the procedures used in testing were described in report Part 2, Trench Liquor Filtration. This testing was conducted on the feed to the clarifier and clarifier overflow at the same body feed ratio.

II. Pilot Scale Testing - The pilot clarifier used was the same one described by LAD-321. The clarifier was 5' diameter by 5' deep, 19.6 ft^2 area, with an adjustable rake speed and overflow weir. The equipment setup is shown by Figure 2. The feed to the clarifier was flow controlled. The NaOCl concentration was measured by a Uniloc ORP cell and automatically controlled by injecting a 3% $Na_2S_2O_3$ solution into the feed line. Brine treating sludge was added as a 5% slurry by a metering pump. The brine sludge was injected into the feed line before a Kenics Mixer. The feed stream was temperature controlled by a small heat exchanger. The feed then dumped into a flocculation tank sized to give 20 to 30 minutes residence time. The tank was agitated by an adjustable speed Lightning Mixer with a single three bladed propeller or by an air driven paddle mixer with two paddles mounted at different heights. The tank was baffled with four 1 1/2" baffles to prevent vortexing. Flocculant was added to the flocculation tank as a 0.1% solution by metering pumps. The clarifier feed came from the bottom of the flocculation tank.

The clarifier overflow was returned to the feed tank from a collection sump. The clarifier sludge line was set up with a timer actuated dump valve, but this was not normally used due to control problems. Periodic sampling of ~ 1 gal of sludge was all that was required to maintain the desired level in the clarifier and 5 to 10% wt solids in the sludge. Sampling of the feed and overflow was done after allowing sufficient time for the clarifier to stabilize after changing conditions (8 to 16 hours normally). The sampling was done as grab samples or as composite samples by periodically adding a small constant volume sample to a composite jug. The samples were routinely analyzed for turbidity and ppm Fe. Selected samples were analyzed for ppm asbestos, Ca, Mg, and NaOCl. Samples of the clarifier sludge were selectively analyzed for % wt solids.

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DISCUSSION OF RESULTS

Lab testing was conducted to determine the optimum conditions for flocculation and settling, and pilot scale testing was conducted to confirm the lab testing and obtain design data. Lab filtration of the sludge from the pilot clarifier and the clarifier overflow were conducted to obtain preliminary filtration data. The results obtained are discussed by the following:

I. Lab Flocculation and Settling Tests - The effective flocculant dosages, optimum brine treating sludge dosage, temperature effects, hypochlorite effects, agitation effects, and hindered settling effects were determined. To evaluate the effects, the clarity was measured by the turbidity, ppm Fe, ppm asbestos, and ppm Ca.

A. Effective Flocculant Dosages - The data obtained for using XD 7338 are presented by Table 1. The flocculant dosage was varied from 1 to 10 ppm with the other variables held constant. The results indicated that 1 to 3 ppm dosage was a minimum effective dosage range. The results are also shown by graph 1.

The data obtained for using Purifloc A-23 are shown by Table 2. The tests were performed at ~ 65°C with the NaOCl neutralized. For these conditions the minimum effective dosage range was also 1 to 3 ppm. These results are also shown by graph 2.

B. Brine Treating Sludge Dosage - The amount of brine treating sludge added was varied from 0 to 600 ppm (dry weight basis). The results obtained are shown by Table 3 and graph 3. The effective dosage in the lab testing was 300 to 400 ppm for XD 7338 or Purifloc A-23.

C. Temperature Effects - The effects of temperature were determined for XD 7338 and Purifloc A-23 as shown by Table 4 and graphs 4 and 5. The clarity using XD 7338 was not affected as much by the temperature as it was for Purifloc A-23. The desired temperature range for using Purifloc A-23 was ~ 50 to 70°C.

D. NaOCl Effects - Neutralizing the NaOCl with $Na_2S_2O_3$ gave better clarity for Purifloc A-23 and XD 7338. The results are shown by Table 5. Purifloc A-23 seemed to be more sensitive to NaOCl than XD 7338 as expected based on Midland Division testing.[1]

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E. Agitation - The type of agitator used and the degree of agitation during the flocculation step affects the size of the flocs formed. A magnetic stirring bar was used to simulate a paddle agitator (low shear) for comparison with a 3-bladed turbine. The results obtained are shown by Table 6. The clarity obtained using the magnetic stirring bar improved with higher agitation. This was probably due to the better contact obtained without shearing. The turbine mixer gave better clarity at slow speeds, but higher speeds broke up the flocs and gave poor clarity in comparison to that for slow speeds.

F. Hindered Settling - Most of the lab testing was conducted without agitation during the settling step. It was suspected that the slight agitation in the continuously flowing pilot clarifier was affecting the clarity obtained (ppm Fe particularly) in comparison with lab testing. To evaluate this possibility, lab testing was conducted using the slowest possible agitation by a magnetic stirring bar during the settling step. The results obtained are shown by Table 7. The higher ppm Fe of the clears with agitation indicated that this was probably one difference in the pilot clarifier results and previous lab testing.

G. Clarity - After 15 minutes settling time the best clarity was obtained using XD 7338 which gave ~ 4 Ftu turbidity, 0.2 ppm Fe, and 0.16 ppm asbestos (93% asbestos removal). Using Purifloc A-23 gave ~ 9 Ftu turbidity and 0.35 ppm asbestos (84% asbestos removal). These results are shown by Table 3. The % asbestos removal and iron removal obtained were similar to that shown by lab testing done by the Midland Division.[2]

II. Pilot Clarifier Operation - Testing was done using XD 7338 and Purifloc A-23 at various flocculant dosages, brine treating sludge dosages, and feed rates. The results were also obtained at various temperatures and NaOCl concentrations. The results are presented by Tables 8 - 10.

A. Effective Flocculant Dosages - The pilot scale testing agreed with the lab testing indicating that ~ 3 ppm would be a minimum effective dosage for XD 7338 or Purifloc A-23. This is shown by Tables 8 and 9.

B. Brine Treating Sludge Dosage - The pilot scale testing did not agree with the lab testing. The results showed that using brine treating sludge resulted in higher turbidities for the clarifier overflow, much higher Ca concentrations, and higher Fe concentrations. These results are shown by Table 10. It would seem that the brine treating sludge was not settling well and causing the poorer clarity. The asbestos removal was not as significantly affected. These results show that no brine treating sludge or < 100 ppm should normally be added.

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C. Effects of NaOCl, Agitation, and Temperature - The testing using Purifloc A-23 was done with and without neutralizing the NaOCl. There was not much difference obtained as shown by Table 9. The data obtained with XD 7338 were all taken without neutralizing the NaOCl. The testing with Purifloc A-23 was done by controlling the temperature at ~ 66°C. Testing using XD 7338 was done over a wide range of temperatures. The results agreed with the lab testing in that the temperature did not greatly affect the results using XD 7338. The clarity obtained at a controlled temperature, however, seemed better by eliminating temperature upsets. The agitation used for the flocculation tank was originally accomplished by using a 3-bladed propeller. Changing to a paddle type agitator (runs 20 through 30) seemed to give slightly better clarity.

The combination of better temperature control and the paddle agitator gave a slight improvement in the clarity (16 Ftu (average) before vs. 9 Ftu (average) after) for using XD 7338 without adding brine treating sludge. This is shown by Table 8, but the effects of the different feed concentrations should be considered as another possible explanation for the improvement.

D. Clarity - The clarity obtained using XD 7338 was slightly better than for using Purifloc A-23 and confirmed the lab testing in that respect. The clarity values obtained did not agree with the lab testing at first. This was due to the addition of brine treating sludge causing higher turbidities in pilot scale testing as discussed previously and due to the slight agitation of the continuously flowing pilot clarifier vs. the unhindered settling used in the original lab testing. The pilot clarifier data obtained compared better with the lab data taken with hindered settling as shown by Table 11. The main problem was with iron removal in that the ppm Fe averaged ~ 1.8 ppm or ~ 40% iron removal vs. ~ 80% removal to values as low as 0.2 ppm Fe in the lab testing. The asbestos removal with XD 7338 was ~ 82% to values as low as 0.3 ppm, and the data agreed fairly well with lab testing. The turbidity of the clarifier overflow using XD 7338 without brine treating sludge averaged ~ 12 Ftu. The turbidity of the overflow using Purifloc A-23 without brine treating sludge also averaged ~ 12 Ftu. Turbidity values as low as 5 Ftu were obtained using XD 7338. The clarity data obtained are shown by Tables 8 and 9. The clarity of the overflow again confirmed the lab testing in that the filtration of the overflow would still be required to obtain acceptable clarity.

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E. Clarifier Feed Rate - The data obtained indicated that ~ 0.25 gpm/ft^2 feed rates would give acceptable clarity, but that ≥ 0.31 gpm/ft^2 feed rates gave poorer overflow clarity for Purifloc A-23. These results are shown by Tables 8 and 9. Operating at 0.15 gpm/ft^2 feed rates could give slightly better clarity, but the increased clarifier size would offset any benefits. The design clarifier rate would be 0.25 gpm/ft^2 to obtain the best clarity when using Purifloc A-23 which could give the lowest flocculant costs.

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III. Lab Filtration - Testing was conducted on the clarifier sludge to determine the approximate flow rates and type of equipment required. Testing on the feed to the clarifier and the clarifier overflow was done to evaluate pressure leaf filtration of the overflow.

A. Vacuum Leaf Filtration - A rotary drum vacuum filter was simulated using the lab vacuum leaf filter on the clarifier sludge. The data are presented in Tables 12 and 13. The clarifier sludge used in the testing was 12.7 wt % solids. This was evaluated using cloth only as shown by Table 12. The cloth blinded easily and the results indicated that a precoat was needed. Three different types of precoat were evaluated (DIC Speedex, Special Speedflow, and DIC 476) using 1" thicknesses. The filtration was simulated at 3 min/rev drum speeds. The filtration rates obtained were ≤ 0.1 gpm/ft^2 with $\sim$ 1/16" thick cakes formed. The filtrate turbidity was $\sim$ 8 Ftu. The cake % (wt) solids was 55%. Dicalite 476 showed less problems of penetration of solids into the precoat than the other two filter aids evaluated. These results are shown by Tables 13A - 13C.

B. Pressure Leaf Filtration ("Bomb" Filter) - Preliminary data were obtained to evaluate the reduction in the amount of filter aid required for pressure leaf filtration when using a clarifier system. The data are shown by Table 14. The feed to the pilot clarifier and the overflow from the pilot clarifier were filtered at the same body feed ratio. The data showed that the amount of filter aid required could be reduced significantly as expected. The bomb filter data did not predict a significant increase in cycle lengths for filtering the lower turbidity clarifier overflow. However, plant testing has shown significantly longer cycle lengths at the lower turbidities.[3] The average inlet turbidity for trench liquor was $\sim$ 30 Ftu and for evaporator feed was $\sim$ 20 Ftu. The average turbidity of the clarifier overflow was $\sim$ 10 Ftu. This would indicate that the amount of filter aid used as body feed could be cut in half for evaporator feed filtration and to $\sim$ one third for trench liquor filtration.

IV. Equipment Sizes and Clarifier System - Based on the results obtained, a clarifier system for the Louisiana Division Caustic Plant would be shown by Figure 3. Based on 0.25 gpm/ft² clarifier feed rates, a 100 ft diameter clarifier would be required for the 2000 gpm trench liquor stream, and a 125 ft diameter clarifier would be required for the 3000 gpm evaporator feed stream. Flocculation tanks (~ 90,000 gals) sized to give ~ 20 to 30 minutes residence time (minimum) would be required for each clarifier. The flocculation tanks would require agitation with paddles and baffles recommended. Flocculant storage tanks and metering pumps would be required with ~ 22,000 gal/day of flocculant added as a 0.1% solution to give 3 ppm dosage. The sludge from the clarifiers could be filtered using a rotary drum vacuum filter with precoat and a scraper discharge. Based on concentrating to ~ 10% wt solids in the sludge, ~ 2 gpm of sludge would be filtered at ~ 0.05 gpm/ft² rate. This would require ~ 40 ft² rotary drum vacuum filter. The clarifier overflow streams would be filtered at ~ 0.75 gpm/ft² feed rates (instead of ~ 0.5 gpm/ft² rates for the filtration only system). The use of 0.75 gpm/ft² filtration rates could eliminate one of the filters, but the elimination of other filter area could only be obtained by using more filters of a smaller size. This is because sluicing would require too much area to be out of service at one time for practical operation. The use of smaller filters would not decrease capital costs very much. The sluice from the pressure leaf filters could be sent to the rotary drum vacuum filter by sluicing with cell effluent and pumping to the trench liquor clarifier as a ~ 40 gpm continuous stream. This would, however, require the rotary drum filter to be much larger. Another alternative would be to send the pressure leaf filter sluice to the brine treating sludge handling system as recommended for the pressure leaf filtration only system. Another alternative would be to send both the clarifier sludge and pressure leaf filter sluice to the brine treating sludge disposal system, and eliminating the rotary drum vacuum filter.

V. Operating Costs (Flocculants and Filter Aid) - The purpose of this testing had been to reduce the high filter aid costs for pressure leaf filtration. The use of a clarifier system would reduce the filter aid costs but, the flocculant costs would offset part of the reduction in filter aid costs. For using XD 7338 at a 3 ppm dosage (~ $1.89/lb XD 7338) the flocculant costs would be ~ $150,000/year or ~ $100,000/year for using a 2 ppm dosage. Using Purifloc A-23 at a 3 ppm dosage would cost ~ $40,000/year for flocculant. The filter aid costs were based on reducing the amount of filter aid for evaporator feed filtration to one half the previous value and on reducing the amount of filter aid for trench liquor filtration to one third the previous amount. This would give filter aid costs of

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~ $80,000/year. The total operating costs (flocculant and filter aid) for the clarifier system would be ~ $180 to 230,000/year for using XD 7338 or ~ $120,000/year for Purifloc A-23. These costs are not as low as desired in comparison to ~ $170,000/year filter aid costs for a pressure leaf filtration only system.[4] The increased capital costs for a clarifier system must also be considered. The calculations used to obtain the costs are given in the Appendix.

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FUTURE WORK

The data presented in this report were used in recommending the asbestos removal system for the Louisiana Division (Part 5). That report discusses the various options available and considers the capital costs, operating costs, and performance of the various removal systems.

ECOLOGICAL CONSIDERATIONS

The techniques advocated in this report would eliminate a source of asbestos from entering the river.

ACKNOWLEDGEMENTS

Rick Wittman and other Caustic Plant personnel were very helpful in setting up the equipment used in this testing.

REFERENCES

1 EMR-LR-130

2 EMR-LR-122

3 Part 4: Evaporator Feed Filtration

4 Part 4: Evaporator Feed Filtration

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FIGURE # 1

LAB FILTER LEAF APPARATUS

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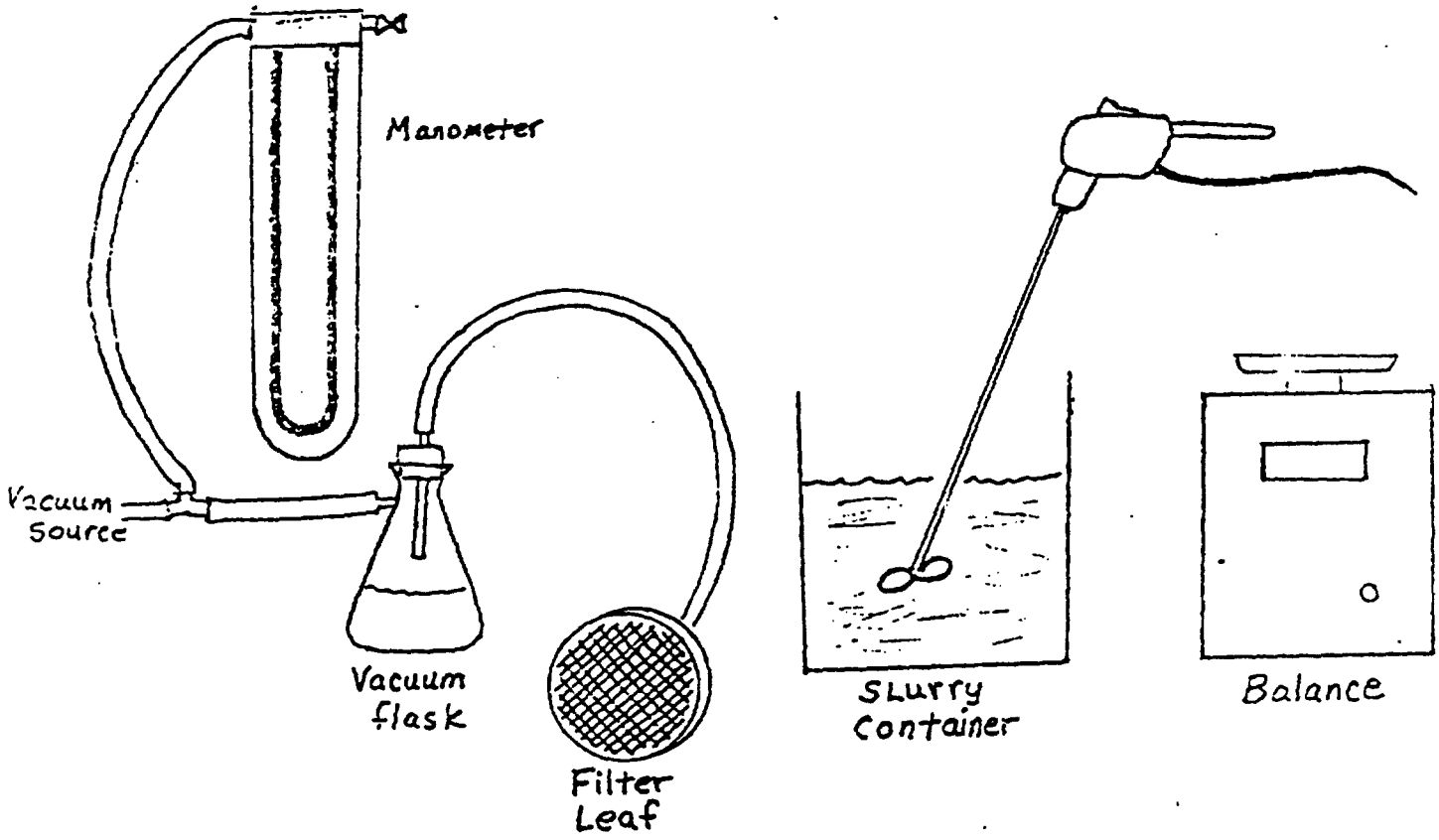

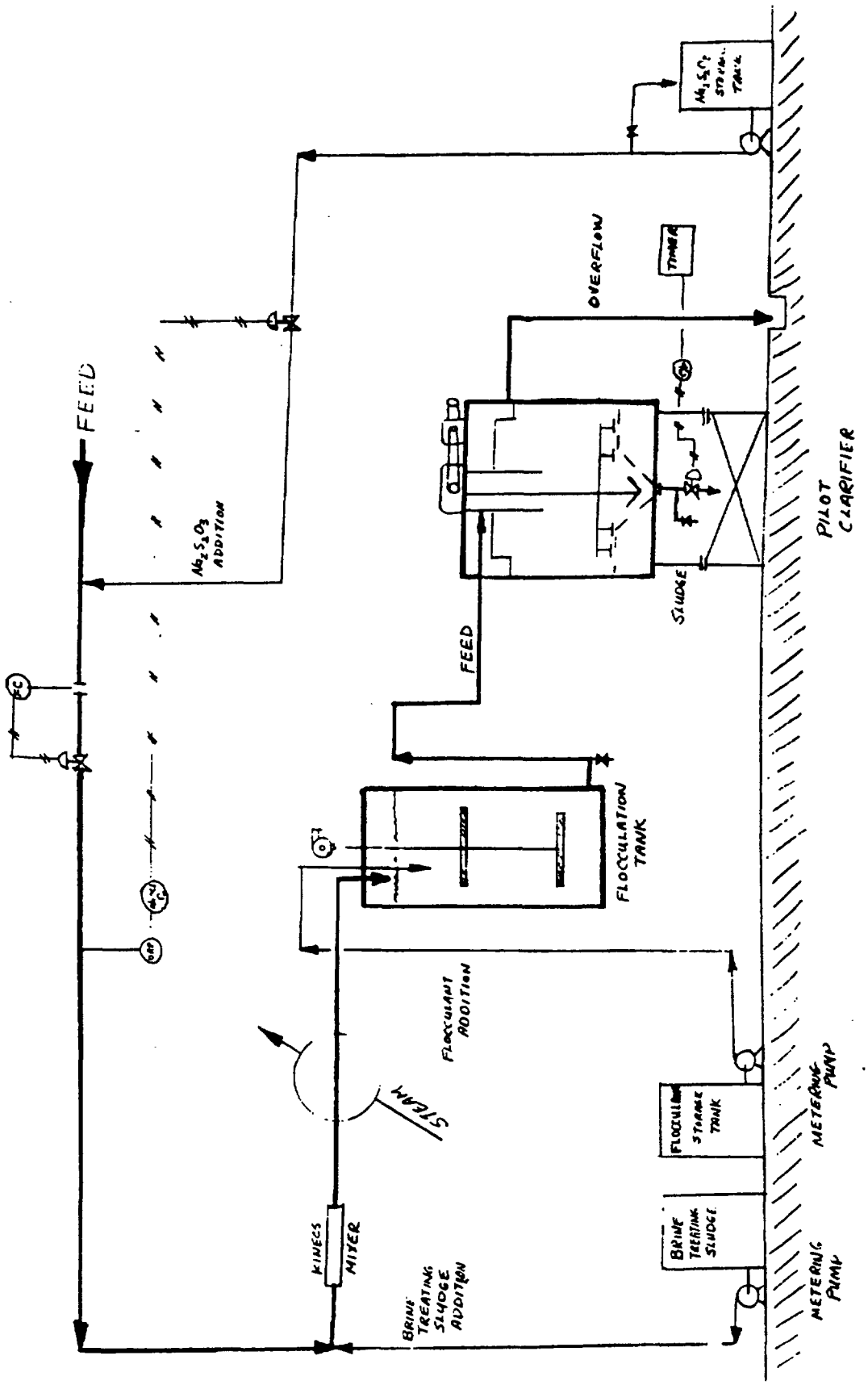

FIGURE #2

PILOT CLARIFIER SYSTEM

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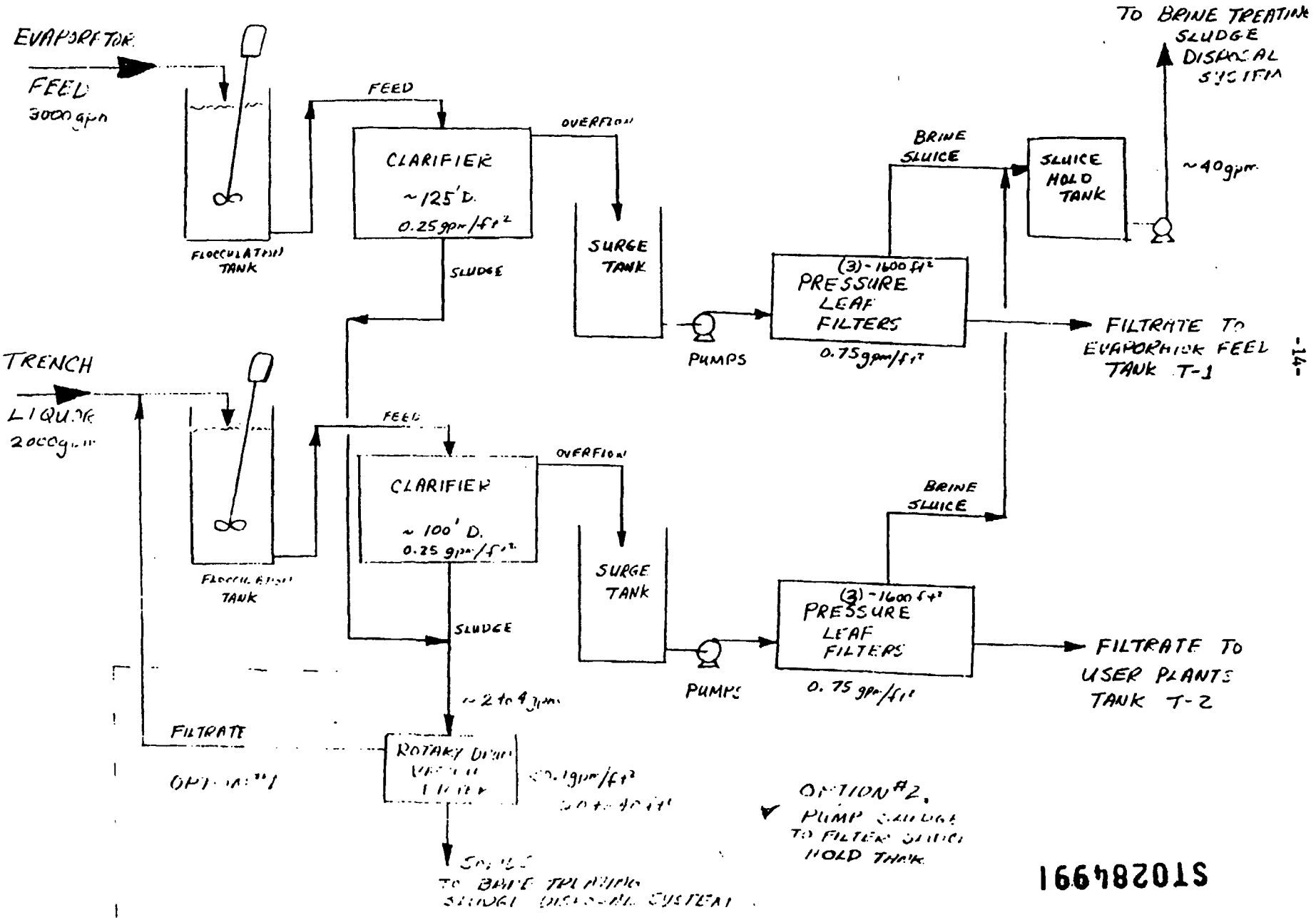
FIGURE #3

FLOCCULATION, SETTLING, AND FILTRATION SYSTEM



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DATA SHEET

TABLE # 1

OPTIMUM FLOCCULANT DOSAGE FOR XD 7338

LAB FLOCCULATION AND SETTLING:

FLOCCULANT TYPE	FLOCCULANT DOSAGE, ppm	BRINE TREATING SLUDGE DOSAGE, ppm	TEMP, °C	ppm $Na_2S_2O_3$ ADDED	FEED TURBIDITY	CLEARS TURBIDITY AFTER 15 MIN	FEED ppm Fe	CLEARS ppm Fe AFTER 15MIN
XD7338	0	400	25	200	42	55	2.9	1.71
"	1	"	"	"	"	8	"	0.60
"	2	"	"	"	"	6	"	0.61
"	3	"	"	"	"	4	"	0.61
"	4	"	"	"	"	7	"	0.58
"	5	"	"	"	"	6	"	0.82
"	6	"	"	"	"	21	"	0.97
"	7	"	"	"	"	12	"	0.81
"	8	"	"	"	"	7	"	0.81
"	9	"	"	"	"	6	"	0.80
"	10	"	"	"	"	5	"	0.64
XD7338	0	400	65	200	30	—	1.33	1.06
"	1	"	"	"	"	"	"	0.41
"	3	"	"	"	"	"	"	0.25
XD7338	3	400	65	200	30	11	1.87	1.35
"	5	"	"	"	"	6.2	"	1.65
"	7	"	"	"	"	14	"	1.7

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TABLE # 2

OPTIMUM FLOCCULANT DOSAGE FOR PURIFLOC A-23

LAB FLOCCULATION AND SETTLING.

	FLOCCULANT TYPE	FLOCCULANT DOSAGE, ppm	BRINE TREATING SLUDGE DOSAGE, ppm	TEMP, °C	ppm $Na_2S_2O_3$ ADDED	FEED TURBIDITY	CLEARS TURBIDITY AFTER 15 MIN	FEED ppm Fe	CLEARS ppm Fe AFTER 15 MIN	FEED ppm ASBESTOS	CLEARS ppm ASBESTOS AFTER 1 HOUR	FEED ppm [illegible]
	PURIFLOC A-23	1	400	65	200	30	8	1.33	0.89	—	—	—
	"	3	"	"	"	"	8	"	0.86	—	—	—
	"	5	"	"	"	"	8.5	"	0.73	—	—	—
	"	7	"	"	"	"	8	"	1.14	—	—	—
	"	10	"	"	"	"	1.5	"	0.99	—	—	—
							AFTER 1 HOUR		AFTER 1 HOUR			
	PURIFLOC A-23	3	0	65	200	27	—	3.83	1.17	—	—	—
	"	5	"	"	"	"	16	"	1.45	—	—	—
	"	7	"	"	"	"	17	"	1.4	—	—	—
	"	10	"	"	"	"	11	"	1.55	2.22	0.83	8.5

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TABLE # 3

OPTIMUM BRINE TREATING SLUDGE DOSAGE

LAB FLOCCULATION AND SETTLING:

	FLOCCULANT TYPE	FLOCCULANT DOSAGE, ppm	BRINE TREATING SLUDGE DOSAGE, ppm	TEMP, °C	ppm $Na_2S_2O_3$ ADDED	FEED TURBIDITY	CLEAR'S TURBIDITY AFTER 15 MIN	FEED ppm Fe	CLEARS ppm Fe AFTER 15 MIN	FEED ppm ASPHALTENES	CLEARS ppm ASPHALTENES AFTER 15 MIN	
	XD7338	10	0	65	200	27	3.5	3.83	—	—	—	—
	"	"	200	"	"	"	3.8	"	—	2.22	0.16	8 c
	"	"	300	"	"	"	3.9	"	—	—	—	—
	"	"	400	"	"	"	4.0	"	0.2	—	—	—
FOR	"	"	500	"	"	"	3.5	"	0.16	—	—	—
XD7338	"	"	600	"	"	"	3.0	"	0.25	—	—	—
	XD7338	10	100	65	200	45	5.0	8.8	2.40	—	—	—
	"	"	200	"	"	"	4.0	"	4.27	—	—	—
	"	"	300	"	"	"	3.5	"	1.29	—	—	—
	"	"	400	"	"	"	3.4	"	1.42	—	—	—
	PURIFLOC A-23	10	100	65	200	45	21	8.8	6.1	—	—	—
	"	"	200	"	"	"	15	"	6.3	—	—	—
	"	"	300	"	"	"	18	"	5.5	—	—	—
FOR	"	"	400	"	"	"	10	"	2.7	—	—	—
PURIFLOC	"	"	500	"	"	"	10	"	2.6	—	—	—
A-23												
	PURIFLOC A-23	10	100	65	200	27	8.6	3.83	—	2.22	0.35	c/c

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TABLE # 4

LAB FLOCCULATION AND SETTLING: EFFECT OF TEMPERATURE

	FLOCCULANT TYPE	FLOCCULANT DOSAGE, ppm	BRINE TREATING SLUDGE DOSAGE, ppm	TEMP, °C	ppm $Na_2S_2O_3$ ADDED	FEED TURBIDITY	CLEARS TURBIDITY AFTER 15 MIN	FEED ppm Fe	CLEARS ppm Fe AFTER 15 MIN
	XD7338	10	400	30	200	56	3	15.5	0.57
FOR	"	"	"	40	"	"	4	"	0.54
XD7338	"	"	"	50	"	"	5	"	0.73
	"	"	"	60	"	"	9	"	0.89
	"	"	"	70	"	"	8	"	0.83
	PURIFLOC A-23	10	400	25	200	27	23	3.83	1.53
	"	"	"	35	"	"	10	"	0.96
	"	"	"	35	"	"	22	"	1.66
	"	"	"	45	"	"	9	"	0.87
FOR	"	"	"	45	"	"	7	"	2.1
PURIFLOC	"	"	"	53	"	"	14	"	1.27
A-23	"	"	"	53	"	"	11	"	1.19
	"	"	"	60	"	"	5	"	1.03
	"	"	"	70	"	"	7.5	"	1.55
	"	"	"	80	"	"	8	"	2.13

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TABLE #5

LAB FLOCCULATION AND SETTLING : EFFECT OF HYPOCHORITE

	Flocculant Type	Flocculant Dosage, ppm	Brine Treating Sludge Dosage, ppm	Temp °C	ppm $Na_2S_2O_3$ Added	Feed Turbidity	Clears Turbidity After 15 min	Feed ppm Fe	Clears ppm Fe After 15 min	Feed ppm NaOCl	
	XD7338	3	400	25	0	23	5	4.24	0.33	21.7	
	"	"	"	"	0	"	4	"	0.5	21.7	
	"	"	"	"	200	"	2	"	0.24	—	
	"	"	"	"	200	"	8	"	0.33	—	
For	"	"	"	"	200	"	11	"	0.41	—	
XD7338											
	XD7338	5	400	25	0	42	9	2.9	0.66	—	
	"	"	"	"	200	"	6	"	0.82	—	
	XD7338	10	100	65	0	33	11	—	1.14	—	
	"	"	"	"	200	"	8	—	0.84	—	
For	Purifloc A-23	10	0	65	0	33	22	—	2.1	—	
Purifloc	"	"	"	"	200	"	17	—	1.31	—	
A-23	"	"	"	"	200	"	11	—	1.55	—	

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TABLE # 6

LAB FLOCCULATION AND SETTLING. • EFFECT OF TYPE OF AGITATION AND DEGREE OF AGITATION (FLOCCULATION STEP)

	FLOCCULANT TYPE	FLOCCULANT DOSAGE, ppm	BRINE TREATING SLUDGE DOSAGE, ppm	TEMP, °C	ppm $Na_2S_2O_3$ ADDED	FEED TURBIDITY	CLEARS TURBIDITY AFTER 15 MIN	FEED ppm Fe	CLEARS ppm Fe AFTER 15 MIN	TYPE OF AGITATOR	AGITATOR SPEED	ppm NaOH
FOR MAGNETIC STIRRING BAR	XD7338	3	400	25	200	23	11	4.24	0.41	MAGNETIC STIRRING BAR	SLOW	—
	"	"	"	"	"	"	8	"	0.33	"	SLOW	—
	"	"	"	"	"	"	4	"	0.25	"	MED	—
	"	"	"	"	"	"	5	"	0.25	"	FAST	—
	"	"	"	"	0	"	5		0.33	"	SLOW	21.7
FOR TURBINE	XD7338	3	400	25	200	23	2	4.24	0.24	TURBINE	SLOW	—
	"	"	"	"	"	"	6	"	0.16	"	MED	—
	"	"	"	"	"	"	5	"	0.49	"	MED	—
	"	"	"	"	"	"	15	"	0.53	"	FAST	—
	"	"	"	"	0	"	4	"	0.5	"	SLOW	21.7

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TABLE # 7

EFFECT OF SLIGHT AGITATION DURING THE SETTLING STEP

LAB FLOCCULATION AND SETTLING.

	FLOCCULANT TYPE	FLOCCULANT DOSAGE, PPM	BENTONITE SLUDGE DOSAGE, PPM	TEMP, °C	PPM $Na_2S_2O_3$ ADDED	FEED TURBIDITY	CLEARS TURBIDITY AFTER 15 MIN	FEED PPM Fe	CLEARS PPM Fe AFTER 15 MIN
	XD7338	10	400	65	200	27	6	3.83	1.43
	"	"	"	"	"	"	5	"	1.36
HINDERED SETTLING	"	"	"	"	"	"	5	"	1.36
	XD7338	3	400	25	200	23	4	4.24	0.62
	XD7338	3	0	25	200	23	4	4.24	1.16
	XD7338	10	400	65	200	27	4	3.83	0.2
UNHINDERED SETTLING	"	"	500	"	"	"	3.5	"	0.16
USUAL LAB TEST	XD7338	3	400	25	200	23	4	4.24	0.25

ST0284998

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TABLE #8 DATA SHEET

CLARIFIER AREA = 19.6 ft²

• EFFECTIVE FLOCCULANT DOSAGE

PILOT CLARIFIER OPERATION • FOR XD7338

DATE AND RUN #	FLOW RATE, GPM / GPM/ft²	FLOCCULANT TYPE	FLOCCULANT DOSAGE, PPM	BRINE TREATING SLUDGE DOSAGE, PPM	PPM Asbestos FEED / PPM Asbestos OVERFLOW	PPM Fe FEED / PPM Fe OVERFLOW	TURBIDITY FTU FEED / TURBIDITY FTU OVERFLOW	PPM Ca FEED / PPM Ca OVERFLOW	CLARIFIER SLUDGE % SOLIDS	CLARIFIER UNDERFLOW RATE, GPH / TEMP °C	PPM NaOH FEED	% NaOH
6	5.5 / 0.28	0	0	0	—	3.5 / 3.3	13 / 15	—	—	/ 45	—	—
*31	4.2 / 0.21	XD7338	3	0	—	2.5 / 2.9	7 / 7	—	—	/ 66	NO THIOSULFATE	
*34	4.2 / 0.21	"	3	0	—	1.26 / 1.14	13 / 8	—	—	/ 66	ADDITION	
*35	4.2 / 0.21	"	4.5	0	—	0.6 / 0.9	20 / 17	—	—	/ 66		
*30	4.2 / 0.21	"	5	0	4.10 / 1.0	2.65 / 1.95	16 / 5	7 / 5	—	/ 66		
18	6 / 0.31	"	5	0	—	—	26 / 10	—	—	/ 55		
19	6 / 0.31	"	5	0	—	—	13 / 11	—	—	/ 49		
8	5 / 0.25	"	7	0	—	3.5 / 1.9	39 / 26	—	—	/ 31		
9	5 / 0.25	"	10	0	1.89 / 0.68	3.2 / 2.1	33 / 11	38 / 11	10	/ 47		
10	5 / 0.25	"	10	0	10.65 / 1.56	7.6 / 5.0	68 / 15	40 / 12	12.7	/ 47		
ALL AVG RUNS	5 / 0.25	XD7338	6	0	5.5 / 1.08	3.0 / 1.8	26 / 12	20 / 9	—	/ 50	—	—

* CONTROLLED CLARIFIER TEMPERATURE AND USING PADDLE AGITATION IN FLOCCULATION TANK

*RUNS AVG	4.2 / 0.21	XD7338	4	0	4.1 / 1.0	1.8 / 1.7	14 / 9	7 / 5	—	/ 66	—	—
OTHER RUNS AVG	5.4 / 0.27	XD7338	7	0	6.26 / 1.12	4.9 / 2.0	38 / 16	39 / 12	—	/ 47	—	—

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LOUISIANA DIVISION
DATA SHEET
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TABLE # 9

CLARIFIER AREA = 19.6 ft²

PILOT CLARIFIER OPERATION

• EFFECTIVE DOSAGE OF PURIFLOC A-23
• + EFFECT OF NaOCl ON PURIFLOC A-23

DATE AND RUN #	FLOW RATE, GPM / GPM/ft²	FLOCCULANT TYPE	FLOCCULANT DOSAGE, PPM	BRINE TREATING SLUDGE DOSAGE, PPM	PPM Asbestos FEED / PPM Asbestos OVERFLOW	PPM Fe FEED / PPM Fe OVERFLOW	TURBIDITY FTU FEED / TURBIDITY FTU OVERFLOW	PPM Ca FEED / PPM Ca OVERFLOW	CLARIFIER SLUDGE % SOLIDS	CLARIFIER UNDERFLOW RATE, GPM / TEMP °C	PPM NaOCl FEED	% NaOH / % NaOCl
6	5.5 / 0.28	0	0	0	—	3.5 / 3.3	13 / 15	—	—	/ 49	—	—
25	5 / 0.25	PURIFLOC A-23	3	"	—	6.7 / 2.9	38 / 20	—	—	/ 67	THIOSULFAT	
27	4.2 / 0.21	"	3	"	3.77 / 1.70	3.2 / 2.7	17 / 13	9 / 6	—	/ 66	ADDITIO	
26	4.2 / 0.21	"	4	"	4.49 / 0.97	3.6 / 1.9	23 / 8.5	12 / 6	—	/ 66	"	"
29	4.2 / 0.21	"	4	"	20.39 / 1.68	4.2 / 1.2	25 / 7	19 / 3	—	/ 66	"	"
AVG	4.4 / 0.22	PURIFLOC A-23	3.5	0	9.6 / 1.5	4.4 / 2.2	26 / 12	13 / 5	—	/ 66	THIOSULFA. ADDITIO	
6	5.5 / 0.28	0	0	0	—	3.5 / 3.3	13 / 15	—	—	/ 49	—	—
36	4.2 / 0.21	PURIFLOC A-23	4.5	0	—	1.3 / 1.5	10 / 8	—	—	/ 66	NO THIOSULFA	
37	4.2 / 0.21	"	6	0	—	1.92 / 1.11	22 / 10	—	—	/ 66	ADDITIO	
38	6 / 0.31	"	4	0	—	—	16 / 32	—	—	/ 66	"	"

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TABLE #10 CLARIFIER AREA = 19.6 ft²

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PILOT CLARIFIER OPERATION • EFFECTIVE BRINE TREATING • SLUDGE DOSAGE

DATE AND RUN #	FLOW RATE, GPM / GPM/ft²	FLOCCULANT TYPE	FLOCCULANT DOSAGE, PPM	BRINE TREATING SLUDGE DOSAGE, PPM	PPM Asbestos FEED / PPM Asbestos OVERFLOW	PPM Fe FEED / PPM Fe OVERFLOW	TURBIDITY FTU FEED / TURBIDITY FTU OVERFLOW	PPM Ca FEED / PPM Ca OVERFLOW	CLARIFIER SLUDGE % SOLIDS	CLARIFIER UNDERFLOW RATE, GPM / °C TEMP	PPM NaOCl FEED	% NaOH / [illegible]
4	4 / 0.2	XD7338	1.5	800	—	1.1 / 1.2	10 / 16	—	—	/ 53	NO	8.2 / 19
21	4 / 0.2	"	4	250	—	2.7 / 1.8	20 / 18	—	—	/ 56	THIOSULFATE ADDITION	—
22	5 / 0.25	"	4	250	—	2.4 / 1.8	20 / 20	—	—	/ 60	"	—
33	4.2 / 0.21	"	4	300	—	—	15 / 22	—	—	/ 66	"	—
32	4.2 / 0.21	"	5	350	—	2.6 / 2.4	15 / 12	—	—	/ 66	"	—
20	6 / 0.31	"	5	350	—	1.8 / 2.7	9 / 20	—	—	/ 54	"	—
15	3 / 0.15	"	6	100	—	2.4 / 1.5	15 / 9	—	—	/ 40	"	6.6 / 13
13	3 / 0.15	"	8	500	2.06 / 0.48	4.1 / 2.3	25 / 22	10 / 23	—	/ 43	"	7.5 / 12
14	4 / 0.2	"	8	100	—	3.7 / 3.5	22 / 23	—	—	/ 50	"	7.4 / 14
12	4 / 0.2	"	10	400	2.3 / 0.3	3.0 / 2.9	23 / 12	20 / 10	—	/ 49	"	25 / 13
5	4.5 / 0.23	"	10	650	—	3.5 / 3.8	35 / 32	—	7	/ 47	"	7.2 / 12
AVG	4.2 / 0.21	XD7338	6	350	2.2 / 0.4	2.5 / 2.2	19 / 19	15 / 16	—	/ —	—	—
23	5 / 0.25	PURIFLOC A-23	3	200	—	2.04 / 1.5	18 / 23	—	—	/ 54	"	—
24	5 / 0.25	"	3	200	—	4.05 / 3.1	25 / 22	—	—	/ 67	"	—
28	4.2 / 0.21	"	3	200	—	1.8 / 1.4	12 / 10	—	—	/ 66	"	—
AVG	4.7 / 0.24	PURIFLOC A-23	3	200	—	2.6 / 2.0	18 / 18	—	—	/ —	—	—

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LOUISIANA DIVISION
DATA SHEET

TABLE # 11

LAB TESTING CLARITY VERSUS PILOT SCALE TESTING CLARITY

TESTING METHOD	FLOCCULANT TYPE	FLOCCULANT DOSAGE, ppm	BRINE TREATING SLUDGE DOSAGE, ppm	FEED TURBIDITY, FTU	OVERFLOW TURBIDITY, FTU	FEED ppm Fe	OVERFLOW ppm Fe	FEED ppm Asbestos	OVERFLOW ppm Asbestos	FEED ppm Ca	OVERFLOW ppm Ca	ST0285002
LAB TESTING	XD7338	10	400	27	4	3.83	0.20	—	—	—	—	
UNHINDERED	"	10	200	27	4	3.83	—	2.22	0.16	8	8	
SETTLING	"	3	400	23	4	4.24	0.25	—	—	—	—	
LAB TESTING	XD7338	10	400	27	6	3.83	1.43	—	—	—	—	
HINDERED	"	3	400	23	4	4.24	0.62	—	—	—	—	
SETTLING	"	3	0	23	4	4.24	1.16	—	—	—	—	
PILOT	XD7338	3	0	13	8	1.26	1.14	—	—	—	—	
CLARIFIER	"	5	0	16	5	2.65	1.95	4.1	1.0	7	5	
	"	10	0	33	11	9.2	2.1	1.89	0.68	38	11	
	"	10	400	23	12	3.0	2.9	2.3	0.3	20	10	
LAB TESTING	PURIFLOC A-23	10	0	27	11	3.83	1.55	2.22	0.83	8	5	
UNHINDERED	"	10	100	27	8.6	3.83	—	2.22	0.35	8	9	
SETTLING	"	3	400	30	8	1.33	0.86	—	—	—	—	
	"	5	0	27	16	3.83	1.45	—	—	—	—	
PILOT	PURIFLOC A-23	4	0	23	8.5	3.6	1.9	4.49	0.97	12	6	
CLARIFIER	"	4	0	25	7	4.2	1.2	20.39	1.68	19	3	
	"	3	200	12	10	1.8	1.4	—	—	—	—	

LOUISIANA DIVISION

DATA SHEET

TABLE # 12 CLOTH EVALUATIONS

LAB VACUUM LEAF FILTRATION TO SIMULATE A ROTARY DRUM VACUUM FILTER

RUN #	FILTER CLOTH NO.	% SOLIDS FEED	FORM TIME, SEC	DRY TIME, SEC	FILTRATE FLOW RATE, GPM/FT²	FILTRATE TURBIDITY, FTU	CAKE THICKNESS, INCHES	CAKE % SOLIDS	DRUM SPEED MIN/REV.
1	PO-801HF	12.7	23	24	0.08	>100	<1/64	—	1

REMARKS: ① CLOTH BLINDED ② CAKE RELEASE BY BLOWING BACK WAS UNACCEPTABLE — WOULD NOT RELEASE ③ CLOTH # PO-801HF WAS A POLYETHYLENE, PLAIN WEAVE, MONOFILAMENT, 40 to 60 CFM AIR FLOW

2	POPR-925F	12.7	45	49	0.08	92	1/32	35	2
3	"	"	"	"	0.09	40	1/64	—	"
4	"	"	"	"	0.08	39	1/64	—	"

REMARKS: ① CLOTH BLINDED, ② CAKE WOULD NOT RELEASE BY BLOWING BACK ③ CLOTH # POPR-925F WAS A POLYPROPYLENE, BASKET WEAVE, MULTIFILAMENT, 1.0 CFM AIR FLOW

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DATA SHEET

TABLE # 13A PRECOAT EVALUATIONS

LAB VACUUM LEAF FILTRATION TO SIMULATE A ROTARY DRUM VACUUM FILTER

RUN #	FILTER CLOTH NO.	% SOLIDS FEED	PRECOAT TYPE	FORM TIME, SEC	DRY TIME, SEC	FILTRATE FLOW RATE, GPM/FT²	FILTRATE TURBIDITY, FTU	CAKE THICKNESS, INCHES	CAKE % SOLIDS	DRUM SPEED MIN/REV		
1	PO-BOINF	12.7	DIC SPEEDEX	67	95	0.05	—	1/64	—	3		
2	"	"	"	"	"	0.09	15	1/64	—	"		
3	"	"	"	"	"	0.09	19	1/64	64	"		

REMARKS: CAKE RELEASE BY SCRAPER TYPE DISCHARGE WAS GOOD. SOLIDS PENETRATION INTO PRECOAT FAIRLY DEEP

TABLE # 13B

1	PO-BOINF	12.7	DIC SPECIAL SPEEDFLOW	67	95	0.16	18	1/32	62	3		
2	"	"	"	"	"	0.15	14	1/32	57	"		
3	"	"	"	"	"	0.09	13	1/32	56	"		
4	"	"	"	"	"	0.09	19	1/32	54	"		

REMARKS: SOLIDS PENETRATION INTO PRECOAT FAIRLY DEEP

TABLE # 13C

1	PO-BOINF	12.7	DIC 476	67	95	0.11	—	1/16	52	3		
2	"	"	"	"	"	0.10	11	1/16	55	"		
3	"	"	"	"	"	0.07	7	1/16	52	"		
4	"	"	"	"	"	0.09	7	1/16	57	"		
5	"	"	"	"	"	0.09	7	1/16	55	"		

REMARKS: CAKE RELEASE BY SCRAPING WAS GOOD. SOLIDS WERE NOT PENETRATING INTO PRECOAT.

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TABLE # 14 DATA SHEET

• @ 10 PSIG CONSTANT PRESSURE

LAB FILTRATION USING "BOMB" PRESSURE LEAF FILTER, @ 0.5" LEAF DIAMETER.

RUN #	FILTER AID MATERIAL	PPM BODY FEED	BODY FEED RATIO	TOTAL FILTRATE VOLUME, ml AFTER 21 MIN	CAKE THICKNESS AT END, INCHES	FEED TURBIDITY FTU	FILTRATE TURBIDITY, FTU	FEED ppm Fe	FILTRATE ppm Fe	REMARKS
108	JMBH40	444	3.7	465	1/4	68	1.5	7.6	0.75	CL-10 FEED
109	"	85	3.7	360	1/16	15	4.5	2.0	1.3	CL-10 OVERFLOW
110	JMBH40	126	3.7	430	1/16	23	3.9	3.0	1.4	CL-12 FEED
111	"	67	3.7	410	1/16	12	6.2	2.9	1.1	CL-12 OVERFLOW
112	JMBH40	137	3.7	150	1/32	25	4.7	4.1	1.5	CL-13 FEED
113	"	120	3.7	220	1/32	22	1.3	2.3	1.7	CL-13 OVERFLOW

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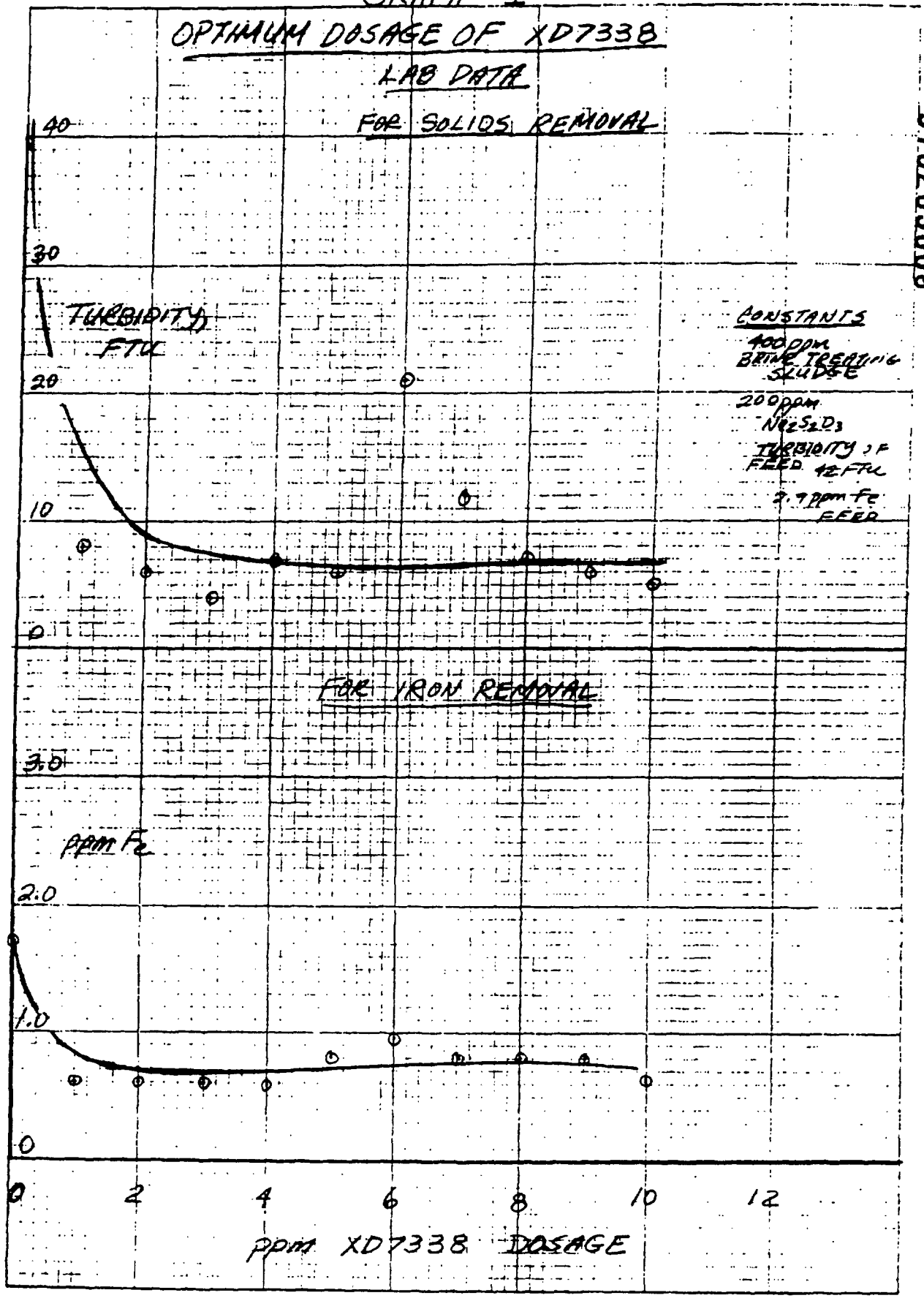
GRAPH # 1



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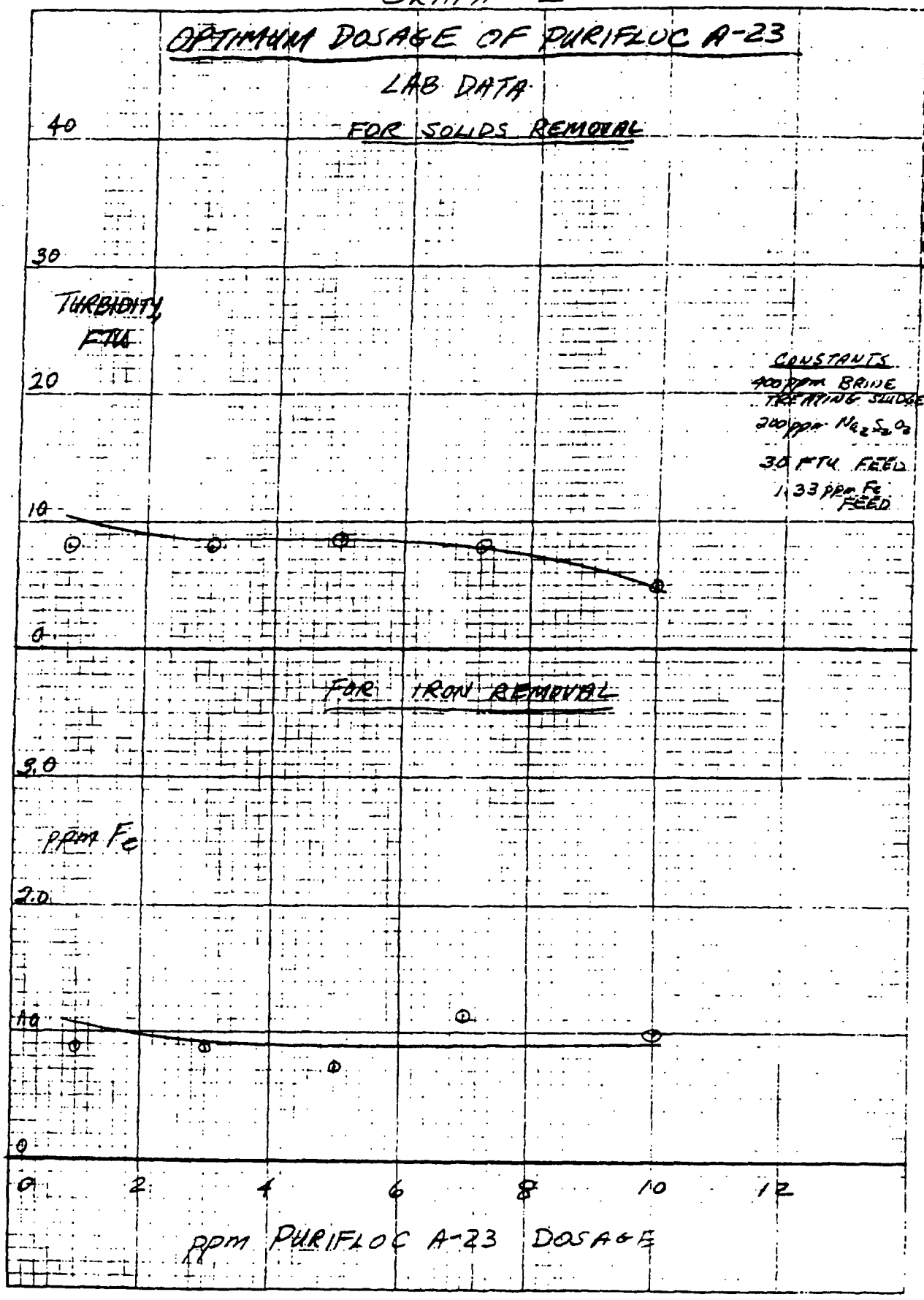
K&E 10 X 10 TO THE INCH 46 0702
KEUFFEL & ESSER CO.

GRAPH # 2



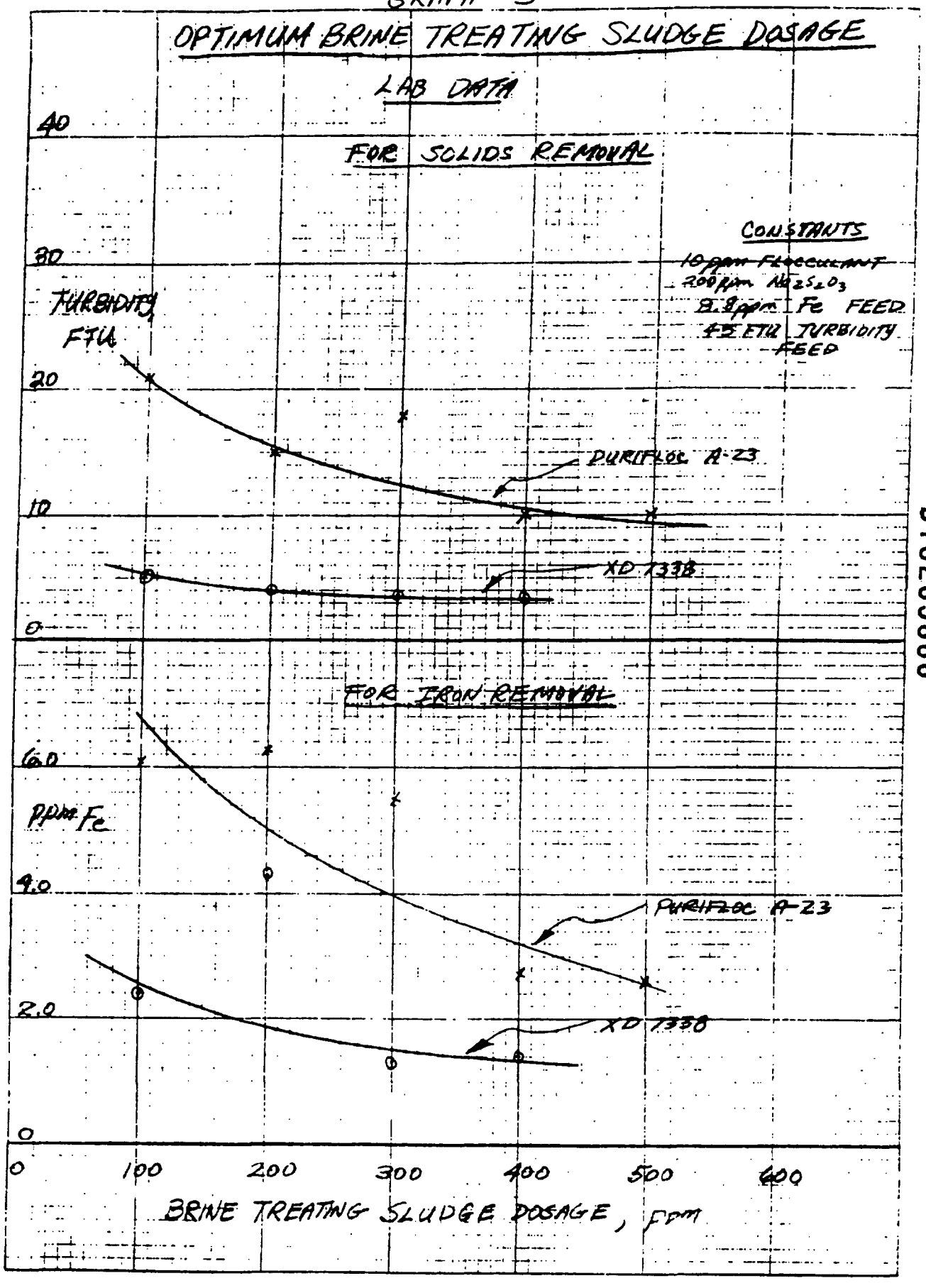
ST0285007

KOE 10 X 10 TO THE INCH 46 0702
KEUFFEL & ESSER CO.

GRAPH # 3

OPTIMUM BRINE TREATING SLUDGE DOSAGE

LAB DATA



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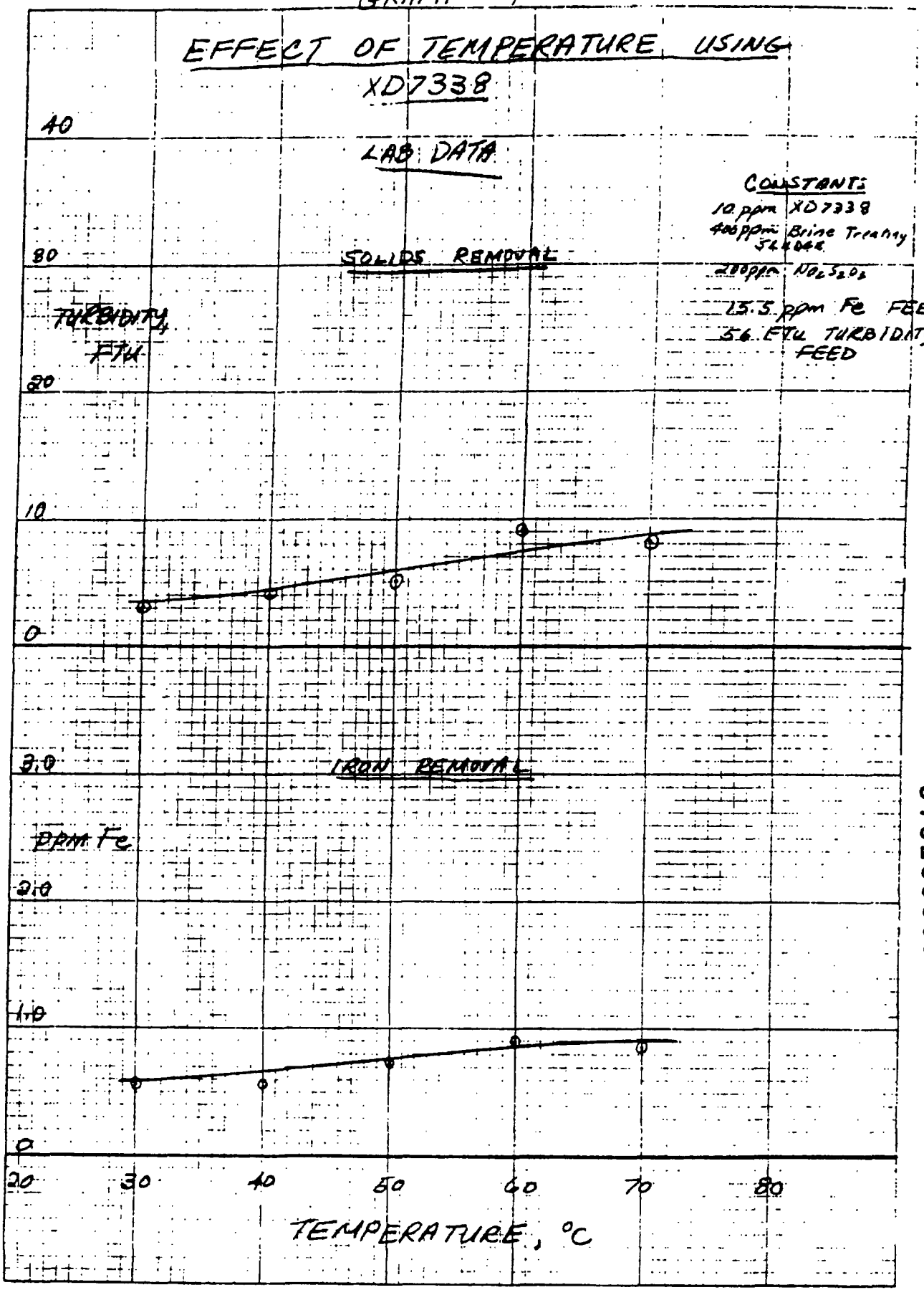
GRAPH # 4

EFFECT OF TEMPERATURE USING XD7338



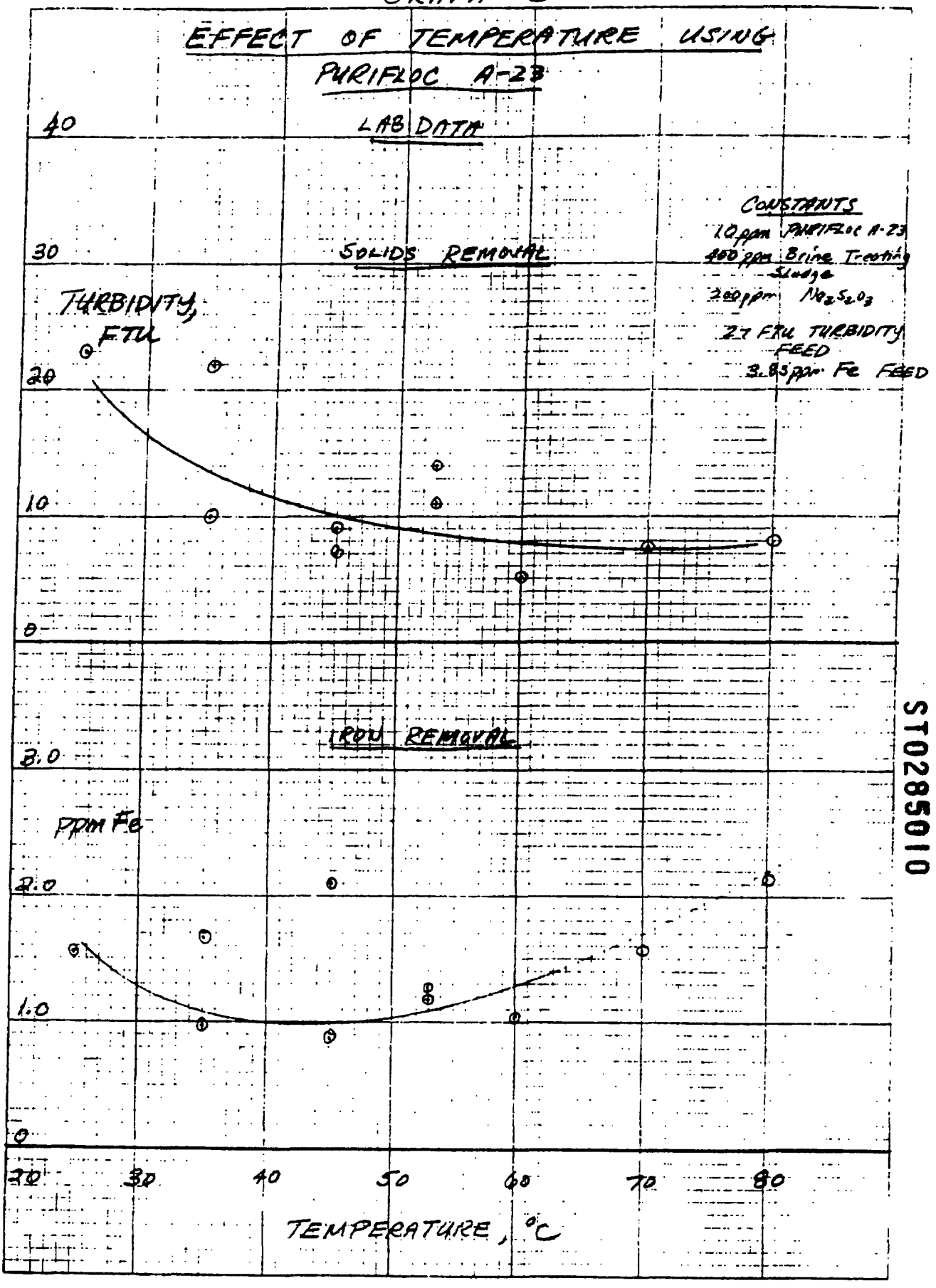
K&E 10 X 10 TO THE INCH 46 0702
7 X 10 INCHES MADE IN U.S.A.
KEUFFEL & ESSER CO.

ST0285009

GRAPH # 5

EFFECT OF TEMPERATURE USING PURIFLOC A-23

LAB DATA



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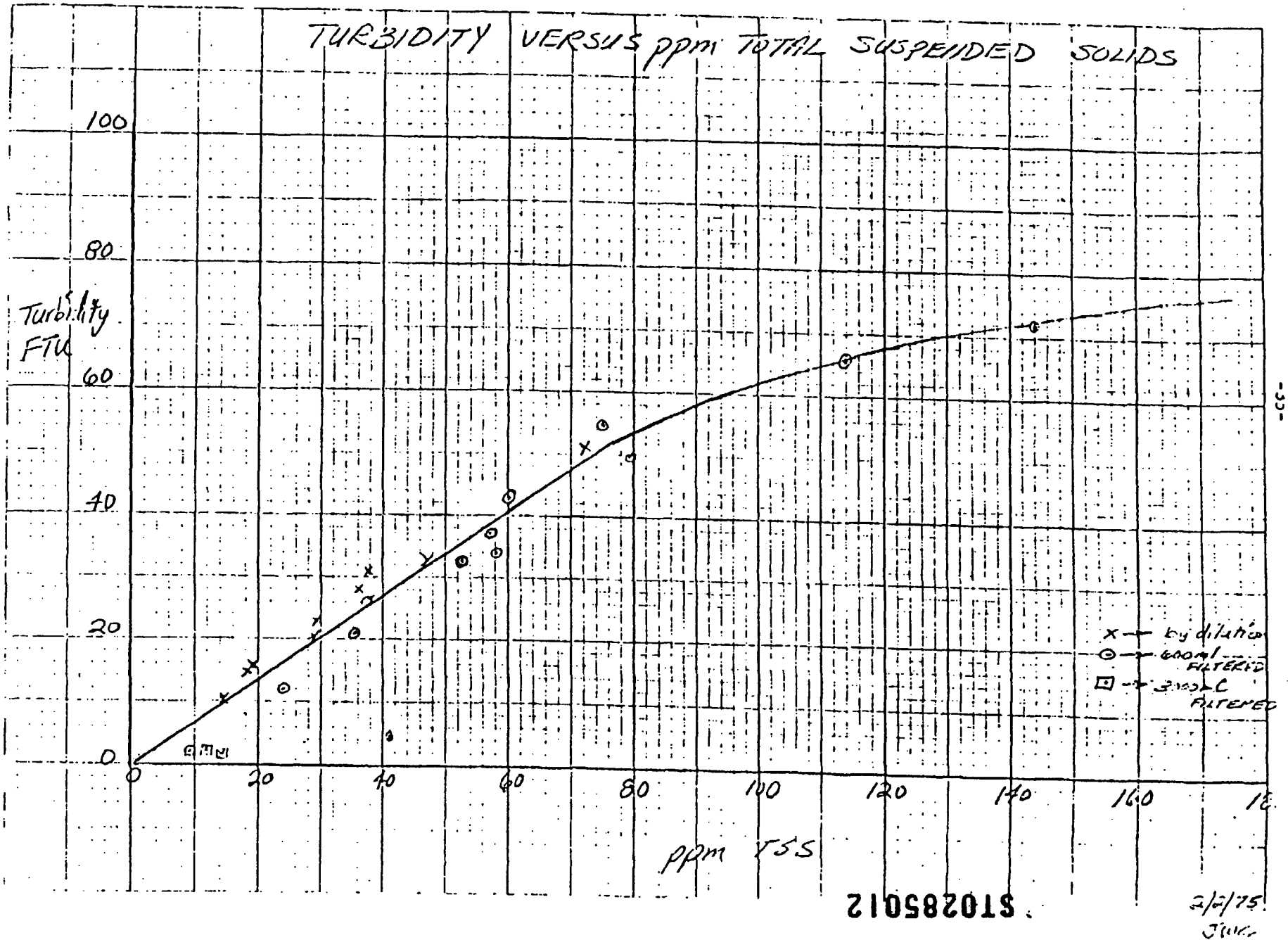
APPENDIX

1. Turbidity Versus ppm Total Suspended Solids Curve
2. ppm Asbestos Versus Transmission Electron Microscope Correlation
3. Sample Calculations

46 0780



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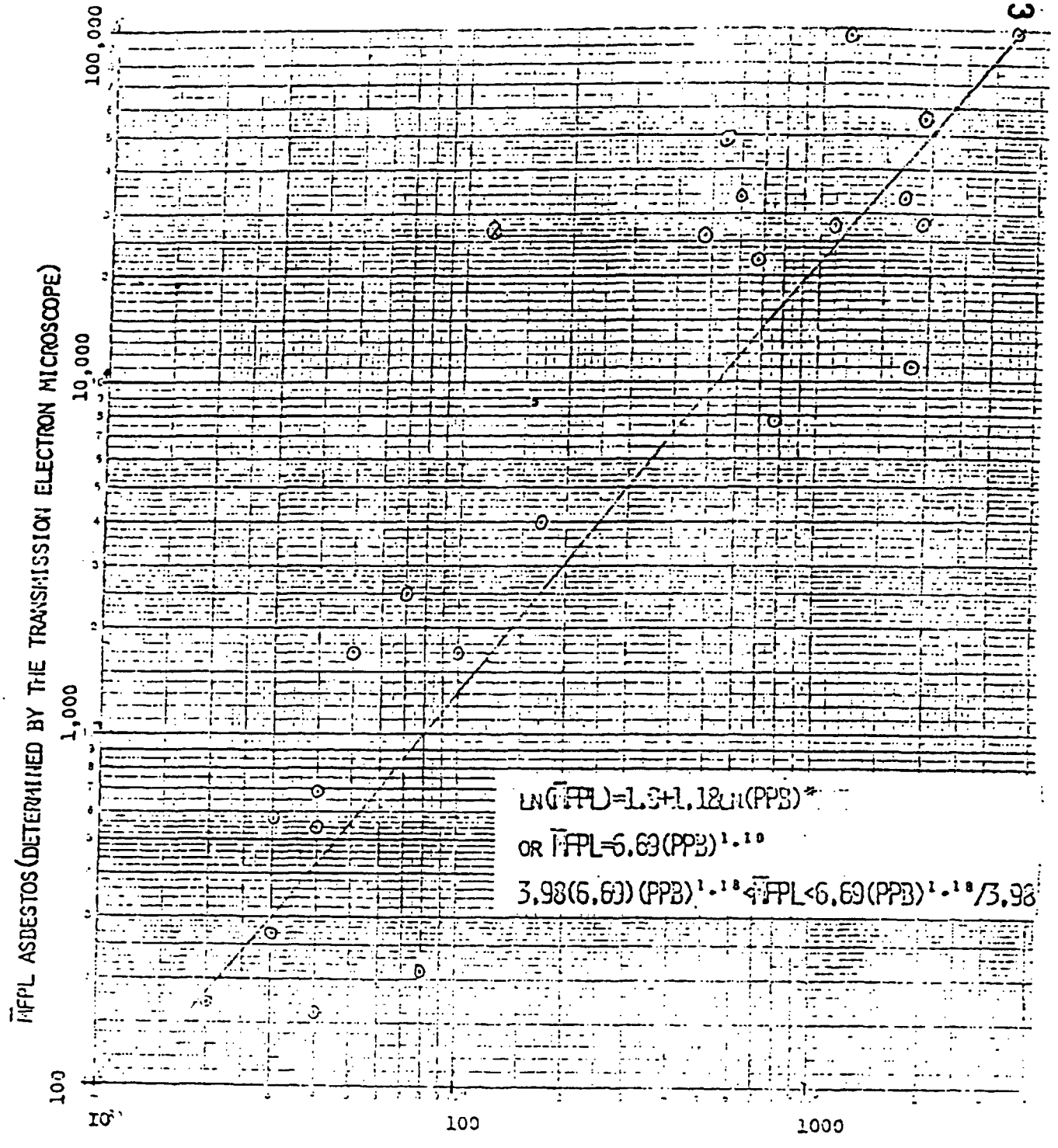
2/2/75
JWC

ST0285013

CONVERSION OF PPB ASBESTOS (WORK BY C. HINZE) TO $\bar{F}$FPL (WORK BY L. MARTIN). THE LIQUID ANALYSED INCLUDES CELL EFFLUENT, BRINE, AND BIO-LAGOON WASTE WATER. THE LINEAR REGRESSION CORRELATION CO-EFFICIENT IS .0/.



*LEAST SQUARES REGRESSION

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SAMPLE CALCULATIONS

I. Trench Liquor and Evaporator Feed Flocculant Costs

A. Lbs Flocculant Required

1. Stream Size → 2000 gpm trench liquor + 3,000 gpm evaporator feed = 5000 gpm

5000 gpm x 10 lb/gal x 60 min/hr x 24 hr/day = 72.0 M̄ lbs/day total stream

72 M̄ lbs/day x 365 days/year = 26,280 M̄ lbs/year total stream

2. For a 3 ppm Dosage of Flocculant

26,280 M̄ lbs/year x 3 ppm floc/stream = 78,840 lbs flocculant/year

B. Flocculant Costs (For 3 ppm dosage)

1. XD 7338 @ $1.89/lb

78,840 lbs floc/year x $1.89/lb XD 7338 = $149,000/year ←

2. Purifloc A-23 @ $0.45/lb

78,840 lbs floc/year x $0.45/lb Purifloc A-23 = $35,480/year ←

II. Filter Aid Costs for Pressure Leaf Filtration

Evaporator Feed and Trench Liquor Streams

A. Precoat Costs - Based on using (5) 1600 ft^2 filters, 0.1 #/ft^2 precoat useage, 12 hour cycles, using DIC 476 @ 5 ¢/lb.

5 x 1600 = 8000 ft^2 filter area

8000 ft^2 x 0.1 # precoat/ft^2 x 2 precoats/day x 365 days/yr = 584,000 lbs precoat/yr

584,000 lb/yr x $0.05/lb DIC 476 = $29,200/yr precoat cost ← trench liquor and evaporator feed

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B. Body Feed Costs - Based on (1) using 1/3 as much body feed for trench liquor filtration and on using 1/2 as much body feed for evaporator feed filtration, (2) using a 3 to 1 body feed ratio of DIC 476 @ 5 ¢/lb, (3) 38 ppm TSS previous average for trench liquor, and (4) 24 ppm TSS previous average for evaporator feed.

1. Previous Cost for Evaporator Feed

3000 gpm x 10 lb/gal x 60 min/hr x 24 hr/day = 43.2 $\bar{M}$ lb/day

43.2 $\bar{M}$ lb/day stream x 24 ppm TSS in feed x $\frac{\text{3 ppm filter aid}}{\text{ppm TSS}}$ = 3,110 lb/day

3,110 lb/day x 365 days/yr x \$0.05/lb DIC 476 = \$56,765/year previous cost

2. Previous Cost for Trench Liquor

2000 gpm x 10/lb gal x 60 min/hr x 24 hr/day = 28.8 $\bar{M}$ lb/day

28.8 $\bar{M}$ lb/day stream x 38 ppm TSS x $\frac{\text{3 ppm DIC 476}}{\text{ppm TSS}}$ = 3,283 lb/day

3,282 lb/day x 365 days/yr x \$0.05/lb DIC 476 = \$59,918/year

3. Filter Aid Cost Reduction for Body Feed

a) Trench Liquor

\$59,918/year previous cost x 1/3 previous cost = \$19,973/year

b) Evaporator Feed

\$56,765/year previous cost x 1/2 previous cost = \$28,383/year

4. Total Body Feed Costs → \$48,356/year

C. Total Filter Aid Costs → \$48,365/year + \$29,200/year = \$77,565/year ←