

75 6192

CRI NUMBER

R & D REPORT

DOW CHEMICAL U.S.

PLAINTIFF'S EXHIBIT

DOW-1218

RI NUMBER

75 6192

LABORATORY REPORT CODE

LAD-385

DATE ISSUED

July 8, 1975

RESTRICTED: for use within The Dow Chemical Company only.

DEPARTMENT

RESEARCH AND DEVELOPMENT

LAB. NO.

274

PROBLEM NO.

TITLE

ASBESTOS REMOVAL, PART 2: FILTRATION OF TRENCH LIQUOR CELL EFFLUENT

46

DOW CONFIDENTIAL

COPIED IN MIDLAND CRI

PAG
IN FL
REPO

AUTHOR(S)

JOHN GROSS

AUTHOR(S) SIGNATURE(S)

John Gross

FEB 19 1987

REVIEWER'S SIGNATURE

*R. O. Bridges*This
report
is:☒ INTERIM☐ FINAL

and mainly:

☒ NEW☐ REVIEWDESCRIPTIVE SUMMARY
WITH CONCLUSIONS:

Include in this space references to data books, and to earlier related reports, patents and publications.)

SUMMARY

Production scale data obtained using a 550 ft² pressure leaf filter on trench liquor (~80 gpl NaOH) cell effluent showed that the asbestos levels were reduced from 3 ppm (~90,000 M FPL) to 0.01 ppm (< 80 M FPL). Iron removal was not required for this stream. A perlite filter aid (Dicalite 476 or 436) is recommended to minimize filter aid costs. At 0.75 gpm/ft² flow rates, cycle times of 6 hours were obtained using Dic 476 as the pre-coat and body feed at a 6 to 1 ratio of body feed to the total suspended solids in the feed. This was for inlet turbidities of 20 to 25 FTU. At the same conditions as above except at a 0.5 gpm/ft² feed rate and a 3 to 1 body feed ratio, cycle times of 8 to 10 hours were obtained.

CONCLUSIONS

1. Asbestos removal was 99+% using pressure leaf filtration and a variety of different filter aids.
2. Iron removal (not required for trench liquor) was from ~2.7 ppm (avg) in the feed to ~1.3 ppm (avg) Fe in the filtrate.
3. Dicalite 476 or 436 would be recommended for trench liquor filtration due to the following:
 - a. These perlites were the cheapest filter aids available at 5¢/lb (diatomites at 10¢/lb, cellulose at 30¢/lb).
 - b. Outlet clarity and reasonable cycle times were obtained.
 - c. Perlites require less complicated bulk handling equipment than diatomites.
 - d. Diatomites may be a health hazard (silicosis).

DISTRIBUTION:

 DEPARTMENT FILES
 R & D ADMINISTRATION
 CENTRAL REPORT INDEX - 5 COPIES
 (566 Bldg. - Midland)

 Distribution list
 is continued on
 attached page.

 RECEIVED
 AUG 7 1975
 MIDLAND

4. The cycle times obtained were affected by the solids concentration of the feed, the type of filter aid used, the body feed ratio, and the filtration rate.
 - a. Cycle times of 6 to 7 hours were obtained using DIC476 as the precoat and body feed at a 6 to 1 body feed ratio for operating at 0.75 gpm/ft² feed rates when the inlet turbidity was 20 to 25 FTU.
 - b. At the same conditions except at 0.5 gpm/ft² feed rates, cycle times of 8 to 10 hours were obtained at a 3 to 1 body feed ratio.
5. Operating at 0.5 gpm/ft³ filtration rates with a 3 to 1 body feed ratio would give the lowest filter aid costs to obtain 8-hour cycles even though more filter area would be required than for operating at 0.75 gpm/ft².
6. The results obtained on the plant scale (550 ft²) filter in general confirmed the testing done by the Midland Division using a pilot scale (20 ft²) filter.

INTRODUCTION

The work covered in this report is an expansion of earlier work done by the Midland Division of filtering cell effluent using a pilot scale (20 ft²) pressure leaf filter (report EMR-LR-120) and lab testing (report EMR-LR-116).² This report is also a continuation of work done by the Louisiana Division on asbestos removal (report LAD-321)³ which was mainly concerned with the cathode washer water. The purpose of this work was to obtain data on filtering trench liquor cell effluent (~ 80 gpl NaOH) and to confirm pilot scale testing on plant scale equipment (550 ft² filter). The Louisiana Division trench liquor contains ~ 2 times as many total suspended solids as the evaporator feed cell effluent. The trench liquor is used by the Glycol Plant and is discharged to the river as part of the hydrolyzer bottoms stream. Asbestos removal is the major consideration, as iron removal is not required. This allowed a choice of less expensive filter aids than the cellulosic type recommended for iron removal by the Midland Division testing.

Other Louisiana Division asbestos removal work now in progress will be reported as Part 3: Filtration of Evaporator Feed Cell Effluent, Part 4: Flocculation and Settling of Cell Effluent Streams, and Part 5: Recommended Asbestos Removal System for the Louisiana Division. Report LAD-321 should be considered as Part 1: Asbestos Removal.

EXPERIMENTAL PROCEDURES AND EQUIPMENT

1. Filter - The filter system is shown by Figure 1. The filter used was an 1100 ft² Sparkler filter originally designed for salt removal with 6" leaf spacing and an outlet manifold designed for 0.1 to 0.15 gpm/ft² flow rates. High pressure drops were obtained through the outlet manifold

ST0002616

when trying to operate at 0.75 gpm/ft² flow rates. The filter had to be modified by removing every other filter leaf to give 550 ft² of filter area to minimize pressure drop at 0.75 gpm/ft². In addition, the measurement of the Δp through the filter was modified by running a tube into the outlet manifold so that the pressure drop across the leaves could be measured instead of the excessive drop through the outlet manifold.

2. Filter Cycle Controls - The filter system was set up for constant rate filtration to a constant Δp at the end of the cycle. The controls were automated as much as practical. The first step was the precoat cycle during which the filter filled up and was precoat until the precoat cycle timed out. Then the "precoat complete" alarm was given. At this point, the operator moved the controls to the filter cycle and began filtering, during which the feed flow rate was automatically controlled. The feed flow rate and Δp across the filter were continuously recorded. At the preset Δp (50 psig), the filter was automatically tripped out of the filter cycle and drained. After the filter was drained, the "ready to sluice" alarm was given. The operator then moved the controls to the sluice cycle, and the filter was automatically sluiced and drained. At that point the "sluice complete" alarm was given. The filter was then ready for another run beginning at the precoat cycle again.

3. Precoat system - The precoat tank was a cone bottom tank equipped with an agitator. The desired quantity of filter aid was added to the tank and the contents of the tank were recirculated through the filter during the precoat cycle. The precoat was normally deposited at a rate of ~ 1 gpm/ft² to give ~ 0.1 # precoat/ft². The filter was filled and precoat with clear liquid to eliminate problems of blinding the filter cloth that occurred at the start of testing when using the feed to the filter.

4. Body Feed System - Body feed is the filter aid added to the filter feed to keep the solids being filtered from rapidly blinding the precoat. Body feed extends the cycle lengths obtained considerably over precoat only for use with trench liquor. The body feed tank used was a 3000 gallon cone bottom tank equipped with an agitator. The desired quantity of filter aid was added to the tank to give the desired slurry concentration (normally 1 to 5 wt. %). The addition rate of body feed was controlled to give the desired ratio of body feed to total suspended solids. This was obtained using a cascade control scheme for which the inlet turbidity was measured by an on stream, Hach surface scatter 4 turbidimeter. The signal from the turbidimeter was fed to a ratio set controller which drove the set point of the body feed flow controller. This allowed the desired ratio of body feed to total suspended solids to be set on the ratio set controller using the relationship between turbidity and ppm TSS (total suspended solids) that had been determined. The body feed rate was measured by the orifice meter, and the tank levels were gauged at the beginning and end of each run to check the flow rate measurement.

ST00002517

5. Sampling and Data Taking - Automatic composite samplers were installed on the inlet to the filter before the point where body feed was injected and on the outlet of the filter. Volumes up to five gallons were obtained during the cycles, and one gal samples were saved for analysis from each run. The turbidity of the inlet stream was continuously measured by the on stream turbidimeter, and samples were also taken periodically and run on the lab turbidimeter. The body feed rate, time, and Δp were also recorded periodically by the operators. The filter feed flow and Δp were continuously recorded. The tank level and time were recorded at the beginning and end of the filter cycle.

6. Sample Analyses - The composite samples were analyzed for ppm Fe, turbidity, ppm NaOCl, % NaOH, and % NaCl by the Caustic Plant lab personnel. The samples were analyzed for ppm asbestos, ppm Ca, ppm Mg, ppm Si, and ppm TSS (total suspended solids) by the R&D analytical lab. All of these analyses were performed by standard analytical procedures.

The ppm asbestos was determined by the A. A. method.⁴ The ppm asbestos can be correlated to M FPL numbers based on a curve correlating the work of Hinze and Martin. Samples were saved for analysis of M FPL by the TEM procedure but this data has not been obtained as yet.

The turbidity was measured using a Hach Model #2100A lab turbidimeter. The samples were placed in an ultrasonic bath just prior to measurement to break up air bubbles from shaking the samples and to break up large flocks formed after the samples settled. This gave good agreement between measurements obtained on hot "fresh" samples and measurements obtained on cold samples that had been allowed to settle.

The ppm TSS were determined gravimetrically by filtering 600 ml of the inlet feed samples or 3000 ml of the outlet samples through a glass fiber filter paper. The filtering was followed by washing with 1000 ml of hot distilled water. These large volumes were found to be needed to eliminate errors caused by being unable to thoroughly wash the salt out of the filter paper and solids. Due to the amount of time required to perform these tests, curves of turbidity vs. ppm TSS and Klett reading vs. ppm TSS were developed and used. These curves are shown by graphs # 1 and 2. The turbidity vs. ppm TSS graph shows that the relationship becomes inaccurate due to a flattening out of the turbidity measurement above ~ 70 FTU. This may be due to nephelometer characteristic of going "blind". The fact that the relationship was a curve rather than a straight line function may also be due to the fact that the large flocks are being broken down into numerous smaller flocks when being diluted by fresh feed into the storage tank. This is typically true of the relationship obtained for many types of flocks when diluted.⁵

7. Lab Pressure Leaf (Bomb) Filter - The lab filter used was a 3000 ml capacity Dicalite bomb filter. The filter was used to quickly compare many different filter aids, and to determine the optimum body feed ratio for a filter aid. The lab filter operated as a constant pressure filter instead of a constant rate filter. This means that the flow rate obtained was an exponential function. By plotting the flow rate vs. time on log-log graph paper, a straight line is obtained which can be extrapolated to an eight-hour or sixteen-hour cycle time. This data can then be used to

ST00003518

calculate the gpm/ft² flow rate that could be obtained for an eight-hour or sixteen-hour cycle of constant rate filtration at an average pressure equal to the constant pressure used in the testing. The calculations and leaf conversion factors are given in the appendix. The data taken were the total volume of filtrate, time in minutes, and filter cake collected thickness, filter leaf area, body feed used, and pressure. Samples were also saved of the filtrate and feed for analysis.

DISCUSSION OF RESULTS

The Louisiana Division trench liquor stream is essentially dirty cell effluent (~ 80 gpl NaOH) and should not be confused with other division's terminology for trench liquor ($\leq$ 20 gpl NaOH) streams. The trench liquor stream is a significantly different stream from the cell effluent tested by the Midland Division using pilot scale equipment. Fe removal was not required for the trench liquor, which is sent to the user plants instead of the evaporators. The lowered Fe specification required for the filtrate allowed the use of cheaper types of filter aids than the cellulosic types recommended for iron removal in the Midland Division testing on cell effluent. Working with trench liquor on a plant scale also gave the opportunity to evaluate data from scaling up from the pilot filter to plant size equipment. The plant scale testing was carried out as constant rate filtration using a variety of different filter aids as precoats and body feeds over a wide range of body feed ratios. The data were obtained at flow rates of 0.75 gpm/ft² and 0.5 gpm/ft². Lab filtration data were also obtained for comparison with the plant filtration data. From these tests the following results were determined:

1. Filter Cycle Times - ~ 8-hour cycles were desired to obtain a reasonable length of time for filtration and to minimize the down time for precoating, sluicing, and mixing of filter aids in the precoat or body feed tanks. The following variables were found to have a major effect on the cycle times obtained:

a. Body Feed Ratio - The cycle times were found to depend upon the body feed ratio used for any filter aid type at a constant inlet feed turbidity and flow rate. This is shown by Tables # 1 - 5. For Dicalite 476 cycle times of 6 to 7 hours were obtained at 0.75 gpm/ft² at a 6 to 1 body feed ratio and inlet turbidity of 20 to 25 FTU. Above ~ 6 to 1 ratio little improvement in cycle times was obtained as shown by graph #3. At flow rates of 0.5 gpm/ft² using Dic 476, cycle times of eight to ten hours were obtained at 3 to 1 body feed ratios with 35 to 37 FTU inlet turbidities. There was little improvement in cycle times above a 3 to 1 ratio as shown by graph #4. In general, these results agreed with the data obtained by the Midland Division, but higher body feed ratios were required.⁶ This may be due to the higher solids concentration in the feed.

The lower body feed ratio needed at 0.5 gpm/ft² feed rates vs. 0.75 gpm/ft² rates would be expected from literature available on filtration. The literature states that to obtain the same throughput at higher flow rates

5100002519

requires more filter aid than at lower flow rates.⁷ The data obtained for Dic 476 using the plant filter were confirmed by the lab testing as shown by graphs #5 and 6 and Tables #6A and 6B. The data agreed in the effect of body feed ratio, optimum body feed ratio, and the effect of inlet solids concentration. The plant data for Dic 436 are shown by graph #7. Lab data for Dic 436 are shown by Tables #7A and 7B and graphs 8 and 9. The literature also agrees with data obtained in determining the optimum body feed ratios in that too high of a body feed ratio can actually reduce the cycle lengths obtained.⁸

b. Feed Turbidity (as a Measure of the Total Suspended Solids Concentration) - The inlet turbidity as a measure of the total suspended solids concentration of the feed has a very significant effect on the cycle times when other variables are held constant. In general, the cycle times decreased as the turbidity increased as shown by graphs #10, 11 and 12. These results confirm those reported by the Midland Division.⁹ The results also agree with the literature available.¹⁰

c. Comparison of Filter Aids - The majority of the plant scale testing was done using Dicalite 476 and 436. A comparison of cycle times obtained at approximately the same conditions showed that Dicalite 476 gave up to one hour longer cycle times than 436. This is shown by graph #13. Other plant scale testing was done using Dicalite 416, Dic 437 and JM hyflo super cel with JM BH 40 as a precoat. These results are shown by Table #5. However, the data given for cycle times by Table #5 may not be accurate due to progressive blinding of the filter cloths that occurred until the filter system was changed to allow the filter to be filled and precoat with clean (pre-filtered) trench liquor. A better comparison of a variety of different filter aids was obtained in lab scale testing. The results of the lab testing are shown by Tables #8A and 8B. The lab scale testing of the perlites confirmed the results obtained in plant scale testing as shown by graphs #14 and 15. The comparison of the cellulose are shown by graphs #16 and 17, and of the diatomites are shown by graphs #18 and 19. These results in general, confirm those obtained by the Midland Division, but there were some differences which may be due to the differences in the two streams tested.¹¹ The choice of filter aids should not, however, be based on cycle times alone.

2. Outlet Clarity - The outlet clarity was measured by turbidity, ppm asbestos, ppm Fe, and ppm Si. The outlet clarity was affected by the type of filter aid used, body feed ratio used, and by the inlet total suspended solids. These effects are discussed by the following.

a. Asbestos Removal - The asbestos removal obtained was from ~ 3.4 ppm (average) to as low as 0.01 ppm, or from ~ 90,000 M FPL to < 80 M FPL based on the A.A. correlation to the TEM. This represents ~99% removal of the asbestos. The inlet asbestos concentration ranged to as high as 15 ppm and the outlet concentration ranged from a high of ~ 0.04 ppm to < 0.01 ppm. These results are given by Tables #1 - 5. A comparison of the filter aids tested showed that Dicalite 416 or 436 consistently gave < 0.01 ppm

5-100002620

outlet asbestos concentrations, and Dicalite 476 gave ~ 0.01 ppm average outlet asbestos concentrations. The results also showed that the outlet asbestos concentration was affected by the body feed ratio used. With precoat only or low body feed ratios (≤ 1), the data showed higher asbestos concentrations than for body feed ratios of two or more.

b. Outlet Turbidity - The outlet turbidity was normally < 2 FTU, and was affected in the same manner that the asbestos concentration was. That is lower outlet turbidities were obtained with "tighter" filter aids or by using a higher body feed ratio. The effect of the body feed ratio is shown by graph #20. The effect of the body feed ratio was also determined by lab testing as shown by graph #21.

c. Outlet Silica Concentration - The data obtained showed that silica pickup was occurring using the perlite or diatomite filter aids. This, however, was not a problem for trench liquor filtration because the trench liquor is not feed to the evaporators and there is no spec for silica. The results obtained are shown by Table #5.

d. Fe Removal - Since iron removal was not required the perlites or diatomites could be used which had been shown to give iron pickup in testing by Midland. On the average, the inlet Fe was ~ 2.7 ppm and the outlet Fe was ~ 1.3 ppm which was ~ 50% removal, but the outlet Fe would not be in spec for 50% NaOH. Again, the iron removal was found to be affected by the body feed ratio with better results obtained above ~1 to 1 ratio. This was seen in the plant testing and lab testing as shown by graphs #20 and 21 and Tables #1 and 6A.

3. Filter Aid Selection - The perlite filter aids would be recommended due to their lower cost than other types of filter aids (5¢/lb for perlites, 10¢/lb diatomites, 30¢/lb for cellulose). The cellulosic types recommended for filtration of evaporator feed cell effluent by Midland Division's testing were not needed for trench liquor because iron removal was not required. The perlites would be preferred over the diatomites due to easier bulk handling for the perlites. The diatomites are also a possible health hazard (silicosis). Of the different grades of perlites, Dic 476 would be preferred to give the longest cycle times with acceptable clarity (0.01 ppm asbestos). If better outlet clarity was desired, Dicalite 436 would be recommended (< 0.01 ppm asbestos).

4. Filter Aid Costs - To obtain eight-hour cycles when operating at 0.75 gpm/ft² filtration rates, the projected costs of filter aids for trench liquor were ~ \$140,000/year. This was based on using Dicalite 476 or 436 as a precoat and body feed at a 6 to 1 body feed ratio and a 0.1# precoat/ft² precoat usage. It was also based on an average inlet turbidity of 26 FTU or 38 ppm total suspended solids, 2000 gpm of trench liquor, and for using two 1600 ft² pressure leaf filters.

ST0002621

A more economical point for operating at 0.75 gpm/ft² would be to obtain ~ 5-hour cycles at a 3 to 1 body feed ratio. This would reduce the filter aid costs to ~ \$90,000/year but would require better automation to reduce the manpower requirements for precoating the filters more often and larger surge tanks. The approximate filter aid costs vs. body feed ratio used at 0.75 gpm/ft² flow rates is shown by graph #22.

For operating at 0.5 gpm/ft² to obtain ~ 10-hour cycles, the filter aid costs would be ~ \$80,000/year. This was based on using a 3 to 1 body feed ratio and on using three 1600 ft² filters. The approximate filter aid costs vs. body feed ratio used at 0.5 gpm/ft² are also shown by graph #22. From these data, it would seem that the lower filter aid costs of operating at 0.5 gpm/ft² could offset the added capital cost for an additional filter if 8 to 10-hour cycles are desired (\$140,000/year vs. \$80,000/year).

RECOMMENDATIONS

Based on the data obtained, the system to filter trench liquor should be designed for 0.5 gpm/ft² filtration rates. A bulk handling system for the perlite filter aids (Dic 476 or 436) should also be considered to reduce manpower requirements. Cycle times of 8 to 10 hours would be expected using a 3 to 1 body feed ratio. Operating at 0.5 gpm/ft² would require three 1600 ft² pressure leaf filters for the Louisiana Division Caustic Plant.

ECOLOGICAL CONSIDERATIONS

The techniques advocated by this report would eliminate a source for asbestos to enter the river. This would be done mainly by eliminating asbestos from entering the river as part of the hydrolyzer bottoms stream.

ACKNOWLEDGEMENTS

Karl McKinstry and Dave Naessens of the Midland Division were very helpful in starting up the 550 ft² plant scale filter at the Louisiana Division and transmitting their knowledge to the Louisiana Division personnel. Rick Wittmann of the Louisiana Division NaOH plant and other NaOH plant personnel set up the filter and operated it during the testing.

sb

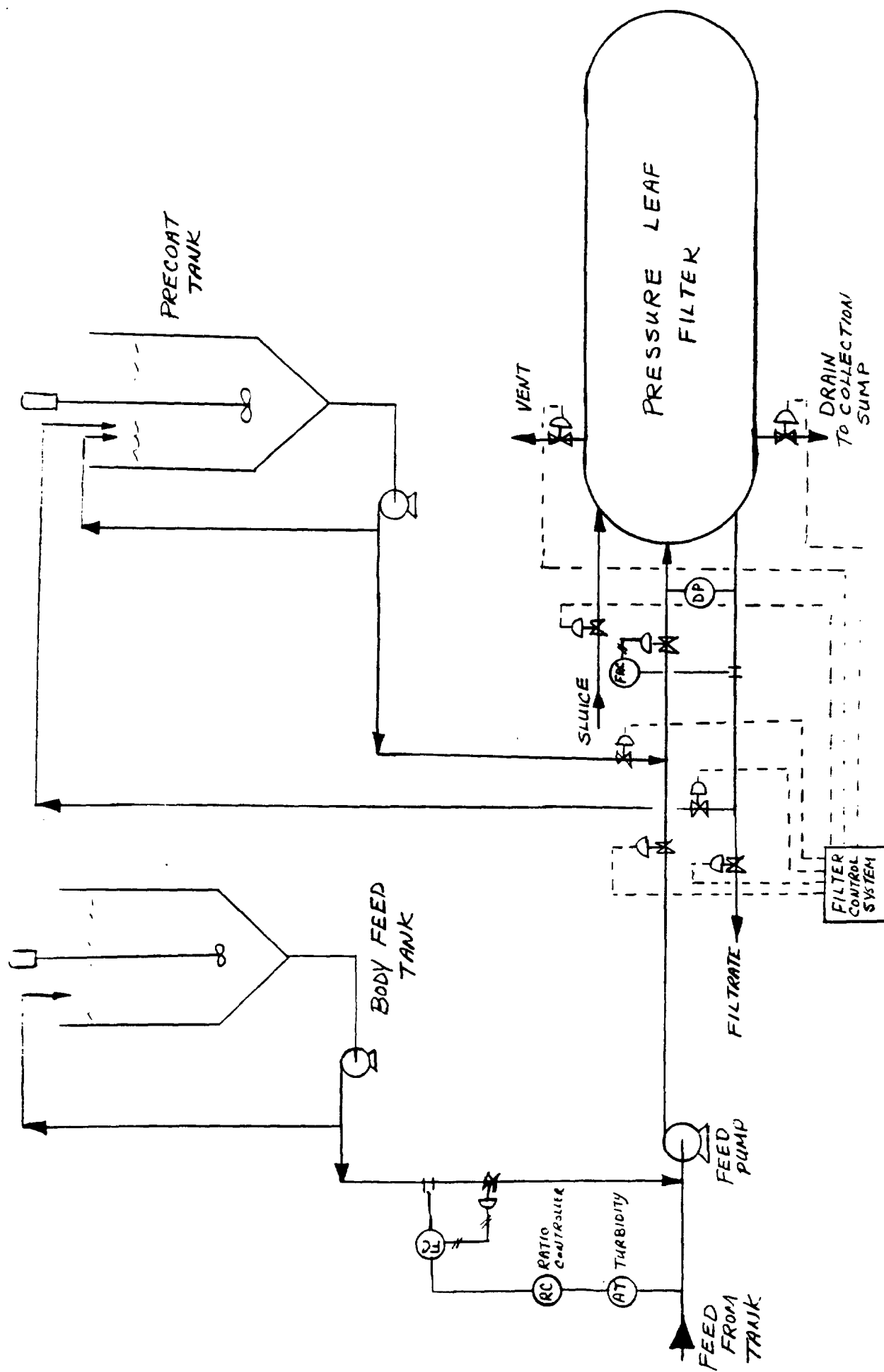
ST00002622

REFERENCES

- ¹Naessens, H. D. and McKinstry, K. A., Report EMR-LR-120 (December, 1974).
- ²Potoff, A. D., Report EMR-LR-116 (December, 1974).
- ³Gross, J. W. and Lanaux, J., Report LAD-321 (December, 1974).
- ⁴Chagnard, H. A., Report LAD-AR-74.01 (November, 1974).
- ⁵Hach Turbidity Measurement, p. 10.
- ⁶Naessens, H. D. and McKinstry, K. A., Report EMR-LR-120 (December, 1974).
- ⁷Johns-Manville Celite Filter Aid Filtration, p. 12.
- ⁸Dicalite Industrial Filtration Manual, p. 15.
- ⁹Naessens, H. D. and McKinstry, K. A., Report EMR-LR-120 (December, 1974).
- ¹⁰Dicalite Industrial Filtration Manual, p. 12.
- ¹¹Potoff, A. D., Report EMR-LR-116 (December, 1974).

ST0002623

FIGURE #1
FILTER SYSTEM



ST00002624



TABLE #3

@ 0.75 gpm/ft² FEED RATE,OPTIMUM BODY FEED RATIO FOR DIC 436. @ 0.1 */ft² PRECOAT, @ ΔP = 50 psi

RUN #	BODY FEED RATIO	CYCLE TIME hrs, min	PPM ASBESTOS IN	PPM ASBESTOS OUT	~MFPL ASBESTOS IN	~MFPL ASBESTOS OUT	TURBIDITY IN	TURBIDITY OUT	PPM TOTAL SUSPENDED SOLIDS IN	PPM Fe IN	PPM Fe OUT
15	4.8	6hr 15min	3.03	<0.01	85,000	<80	21	1.6	33	3.2	3.8
16	8.4	6hr 50min	3.19	<0.01	90,000	<80	20	1.4	31	2.3	2.6
20	5.1	4hr 5min	3.51	<0.01	109,000	<80	30	2.4	47	2.3	1.5
22	6.2	3hr 45min	3.09	0.02	81,000	180	30	0.8	47	0.82	0.86
18	6.2	3hr 35min	5.94	0.03	110,000	300	32	2.5	53	2.0	1.5
19A	10.7	5hr 20min	2.80	0.02	80,000	180	27	1.5	43	0.89	0.82
38	4.9	2hr 28min	—	—	—	—	37	1.6	57	3.9	0.5
39	8.3	3hr 55min	3.43	0.01	100,000	80	35	5	54	1.93	1.2

TABLE #4

@ 0.5 gpm/ft²

36	6.8	8hr	—	—	—	—	26	1.5	41	2.6	0.4
35	8.8	10hr 15min	2.25	0.01			25	2.8	40	3.2	0.8

TABLE # 5

DATA SHEET

@ 0.75 gpm/ft² FEED RATE,
COMPARISON OF FILTER AIDS: @ 0.1*PRECOAT/ft² (BEFORE REPLACED BLINDED BA

RUN #	PRECOAT MATERIAL	BODY FEED MATERIAL	CYCLE TIME hr, min	ppm Fe IN	ppm Fe OUT	ppm Asbestos IN	ppm Asbestos OUT	~ AFPL Asbestos IN	~ AFPL Asbestos OUT	ppm Si IN	ppm Si OUT	ppm TSS IN	ppm TSS OUT	FTU TURBIDITY IN	FTU TURBIDITY OUT	PPM BODY FEED	PPM BODY FEED
2	DIC 476	DIC 476	1hr Bmin	3.2	1.1	5.31	0.02	~140,000	180	-	-	48	32	2	270	5.	
3	DIC 476	DIC 476	2hr 45min	3.0	1.3	5.12	0.04	~140,000	430	-	-	42	28	1.5	440	10.	
4	DIC 476	DIC 476	4hr 18min	0.5	0.8	5.81	0.14	~180,000	2,000	-	-	48	32	2	600	12.	
5	DIC 476	DIC 476	4hr 55min	0.5	0.9	4.82	0.02	~140,000	180	7	36	42	31	1.5	800	19	
6	DIC 437	DIC 437	6hr 45min	1.4	0.5	5.78	0.01	~180,000	80	6	21	43	29	2	400	9.	
7	DIC 437	DIC 437	5hr 30min	1.6	0.4	6.70	0.01	~200,000	80	-	-	56	38	2	560	10	
8A	DIC 476	DIC 416	55min	1.5	0.3	5.02	0.02	~140,000	180	-	-	48	33	2	280	5.	
8B	DIC 476	DIC 416	2hr	1.1	0.8	5.81	0.01	~180,000	80	-	-	48	33	3	410	8.	
8C	DIC 476	DIC 416	2hr 30min	1.2	1.1	9.67	0.01	~310,000	80	7	35	71	48	2.5	540	7.6	
8D	DIC 476	DIC 416	1hr 30min	2.3	0.6	12.0	0.01	~800,000	80	-	-	71	48	4.5	580	8.2	
8E	DIC 476	DIC 416	2hr 10min	-	-	-	-	-	-	-	-	-	-	-	460	-	
9	JMBH40	JM HYFLO SUPERCCEL	1hr 35min	3.4	1.1	14.78	<0.01	~400,000	<80	-	-	78	53	1.5	900	11.5	
9A	JMBH40	JM HYFLO SUPERCCEL	2hr 10min	3.2	1.1	12.64	0.01	~800,000	80	-	-	50	32	1.1	840	16.	
9B	JMBH40	JM HYFLO SUPERCCEL	3hr 30min	2.3	0.9	6.60	0.02	~210,000	180	7	17	34	22	0.5	590	17.4	
13	DIC 436	DIC 436	2hr	5.8	1.4	6.11	<0.01	~180,000	<80	-	-	76	52	1.9	480	6.3	
12A	DIC 436	DIC 436	1hr 45min	1.8	1.1	4.54	<0.01	~140,000	580	-	-	48	33	2	420	8.8	
14	DIC 436	DIC 436	1hr 7min	6.8	1.55	6.89	<0.01	~200,000	80	-	-	83	55	1.5	800	9.6	
12	DIC 436	DIC 436	1hr 15min	1.5	0.5	4.77	<0.01	~140,000	<80	-	-	40	27	1.5	440	11	
10B	DIC 436	DIC 436	2hr 45min	1.7	1.3	2.74	<0.01	~70,000	80	-	-	34	22	0.5	390	11.5	
10C	DIC 436	DIC 436	2hr 0min	4.1	1.7	4.59	<0.01	~40,000	80	-	-	40	25	2	530	13.3	
10A	DIC 436	DIC 436	3hr 35min	1.7	1.1	4.92	<0.01	~140,000	<80	-	-	40	25	0.6	590	14.8	
10	DIC 436	DIC 436	1hr 45min	2	1.2	7.46	0.02	~250,000	180	-	-	50	32	1.6	870	17.4	
11	DIC 436	DIC 436	2hr 25min	1.8	1.2	4.64	<0.01	~140,000	<80	-	-	40	27	0.5	740	18.5	

879700015

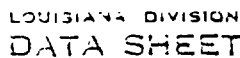
829260015

TABLE # 6A

1/25/75

LAB FILTRATION OF TRENCH LIQUOR. OPTIMUM BODY FEED RATIO FOR DIC.

RUN #	grams of DIC 476 Added to 300ml	PPM DIC 476 BODY FEED	BODY FEED RATIO	TOTAL FLOW AFTER 21min, ml 0.5" LEAF DIAMETER @ 25 PSIG	CAKE THICKNESS AFTER 21min, INCHES	PPM Fe OUT	TURBIDITY OUT, FTU
75	0	0	0	1860	~0	4.5	20
74	0.05	14	0.22	755	~1/16"	4.4	15
73	0.10	28	0.44	775	~1/32"	5.6	9.0
76	0.2	56	0.88	1075	~1/16"	6.1	8.5
77	0.5	139	2.2	1040	~1/8"	3.6	5.7
78	1.0	278	4.3	1390	~3/8"	2.4	2.5
79	2.0	556	8.7	1755	—	2.3	2.5
80	3.0	834	13.0	1740	7/8"	2.6	1.9
TURBIDITY IN 41 FTU ppm TSS 64 ppm ppm Fe 8.0 ppm ppm Asbestos 3.03 ppm % NaOH 7.81 % % NaCl 16.17 %							
LAB FILTER FEED ANALYSIS							
0.5" LEAF DIAMETER 25 PSIG POLYPROPYLENE CLOTH ~80 CFM AIR FLOW							



and 1/19/75
1/21/75

RUN #	Grams of DIC 476 Added to 3000ml	ppm DIC 476 BODY FEED	BODY FEED RATIO	TOTAL FLOW AFTER 21min, ml 0.956" LEAF DIAMETER 25 PSIG	CAKE THICKNESS AFTER 21min, INCHES	ppm Fe OUT	TURBIDITY OUT, FTU
35	0	0	0	460	1/32"	—	—
42	0.2	56	2	2135	1/16"	—	—
43	0.4	111	4	2565	3/16"	—	—
38	0.5	139	5	2310	3/16"	—	—
39	1.0	278	9.9	2315	5/16"	—	—
40	2.0	556	19.9	2410	9/16"	0.08	5.5
41	3.0	834	29.8	2455	—	—	—
36	4.0	1111	39.7	2140	1 1/16"	—	—
37	5.0	1389	49.6	2040	1 1/16"	—	—
IN TURBIDITY 18 FTU ppm TSS 28 ppm ppm Fe 2.2 ppm ppm Asbestos 2.05 ppm % NaOH 6.20 % % NaCl 16.71 % LAB FILTER FEED ANALYSIS 0.956" LEAF DIAMETER 25.0 PSIG POLYPROPYLENE CLOTH.							



TABLE #7B

1/25/75

LAB FILTRATION OF TRENCH LIQUOR: OPTIMUM BODY FEED RATIO FOR DIC

RUN #	grams of DIC 436 Added to 3000 ml	ppm of DIC 476 BODY FEED	BODY FEED RATIO	TOTAL FLOW AFTER 21 min, 1 0.5" LEAF DIAMETER @ 25 PSIG	CAKE THICKNESS AFTER 21 min, INCHES	PPM Fe OUT	TURBIDITY OUT, FTU						
75	0	0	0	1860	0	4.5	20						
82	0.1	28	0.44	925	3/16"	—	—						
83	0.2	56	0.88	875	—	—	—						
84	0.5	139	2.2	965	—	3.4	7.0						
81	1.0	278	4.3	930	—	—	—						
85	2.0	556	8.7	835	9/16"	2.9	4.0						
IN													
TURBIDITY	41	FTU											
PPM TSS	64	PPM											
PPM Fe	8	PPM											
PPM Asbestos	3.03	PPM											
% NaOH	7.81	%											
% NaCl	16.17	%											
PPM Si													
LAB FILTER FEED ANALYSIS													
0.5" LEAF DIAMETER													
25 PSIG													
POLYPROPYLENE CLOTH ~80 CFM AIR FLOW													

ST0002502



TABLE 8A

1/18/75

LAB FILTRATION OF TRENCH LIQUOR: COMPARISON OF FILTER AIDS

RUN #	TYPE OF FILTER AID	PPM BODY FEED	BODY FEED RATIO	TOTAL FLOW AFTER 21 min, ml 0.956" LEAF DIAMETER @ 10 PSIG	PPM Fe OUT	TURBIDITY OUT	CAKE THICKNESS AFTER 21 min, INCHES				
PERLITES { 22	DIC 476	417	13.9	2480	0.96	0.9	1/4"				
21	DIC 436	417	13.9	1990	0.89	1.3	1/4"				
19	DIC 416	417	13.9	1410	1.10	1.0	3/16"				
25	DIC SPEEDEX	417	13.9	2900	0.79	0.8	—				
26	DIC SPEEDRINS	417	13.9	2800	0.65	1.9	—				
24	JM MYRO SUPERCCEL	417	13.9	2190	0.97	2.0	1/4"				
DIATOMITES { 28	DIC 231	417	13.9	1580	0.65	1.9	1/32"				
27	DIC SUPERAID	417	13.9	875	0.65	2.0	1/8"				
20	DIC 215	417	13.9	800	0.96	1.5	1/8"				
16	JMBH40	417	13.9	2075	0.9	0.5	1/4"				
CELLULOSIC { 17	DIC BW 100	417	13.9	1775	—	—	5/16"				
18	DIC BW 200	417	13.9	1575	0.63	1.9	1/4"				
23	DUCK CLOTH	0	0	1650	0.73	1.1	<1/32"				
IN											
TURBIDITY	20	FTU									
PPM TSS	30	PPM									
PPM Fe	2.4	PPM									
PPM ASBESTOS	3.03	PPM									
% NaOH	6.27	%									
% NaCl	17.16	%									
LAB FILTER FEED ANALYSIS											
0.956" LEAF DIAMETER											
10 PSIG											
DUCK CLOTH											

ST0002533



TABLE #8B

1/19/75

LAB FILTRATION OF TRENCH LIQUOR: COMPARISON OF FILTER AIDS

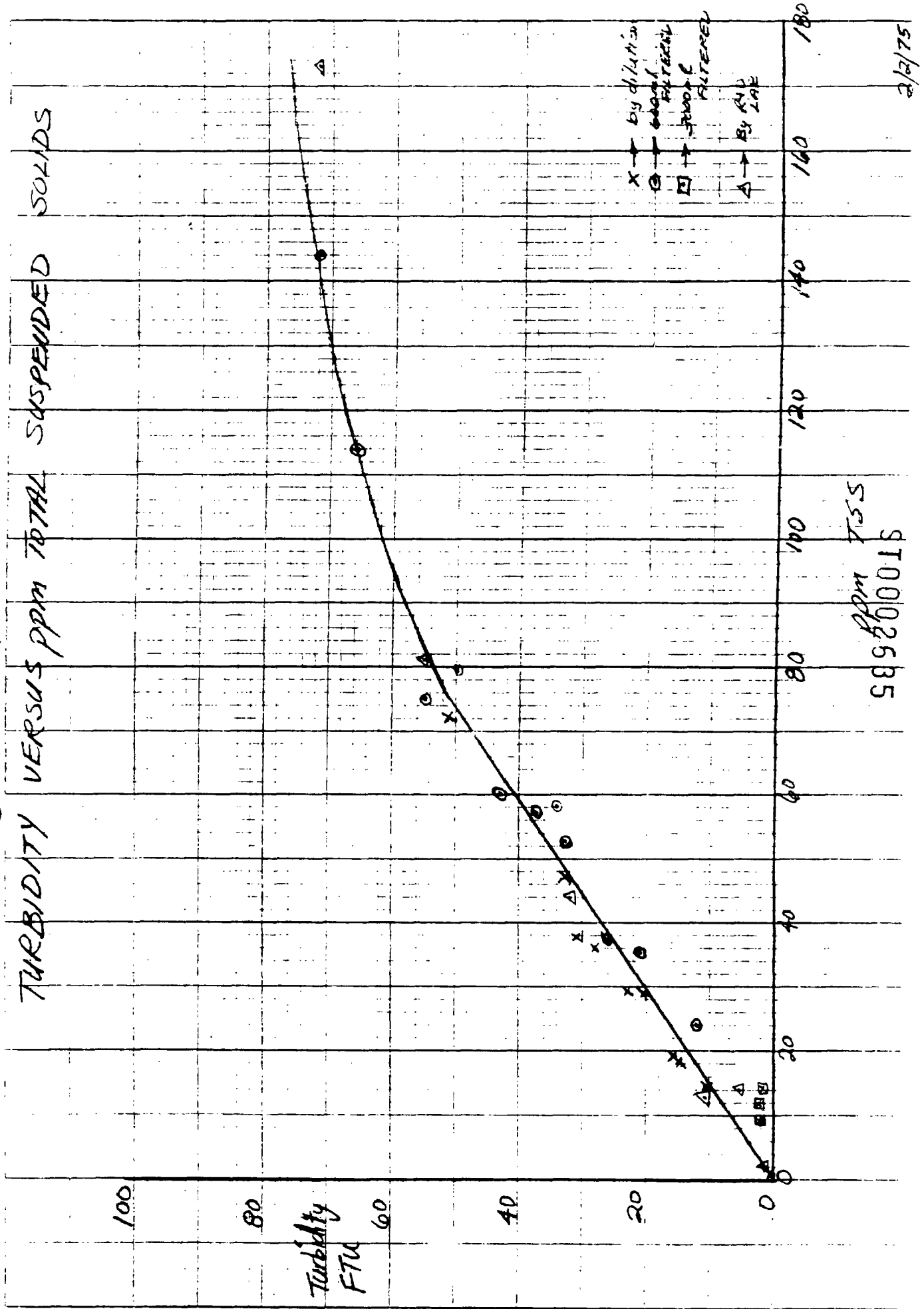
RUN#	TYPE OF FILTER AID	PPM BODY FEED	BODY FEED RATIO	TOTAL FLOW AFTER 21 min, ml 0.956" LEAF DIAMETER @ 25 PSIG	PPM Fe OUT	TURBIDITY OUT	CAKE THICKNESS AFTER 21 min, INCHES				
140	DIC 476	555	30.8	2410	0.08	5.5	9/16"				
PERLITES { 30	DIC 436	555	30.8	2080	0.65	3.0	4/16"				
31	DIC 416	555	30.8	1350	0.49	2.4	5/16"				
DIATOMITES { 34	JM HYFLO SUPERCEL	555	30.8	1910	0.33	3.0	5/16"				
32	DIC 215	555	30.8	1075	0.90	1.5	1/16"				
CELLULOSIC 33	JM BH 40	555	30.8	1595	0.08	2.5	3/8"				
35	POLYPROPYLENE CLOTH	0	0	460	-	-	1/32"				
IN											
TURBIDITY	18	FTU	LAB FILTER FEED ANALYSIS								
ppm TSS	28	ppm									
ppm Fe	2.2	ppm									
ppm ASBESTOS	2.05	ppm									
% NaOH	6.06	%									
% NaCl	17.17	%									
0.956" LEAF DIAMETER 25 PSIG POLYPROPYLENE CLOTH											

ST00002631

ST0002634

GRAPH # 1

TURBIDITY VERSUS ppm TOTAL SUSPENDED SOLIDS

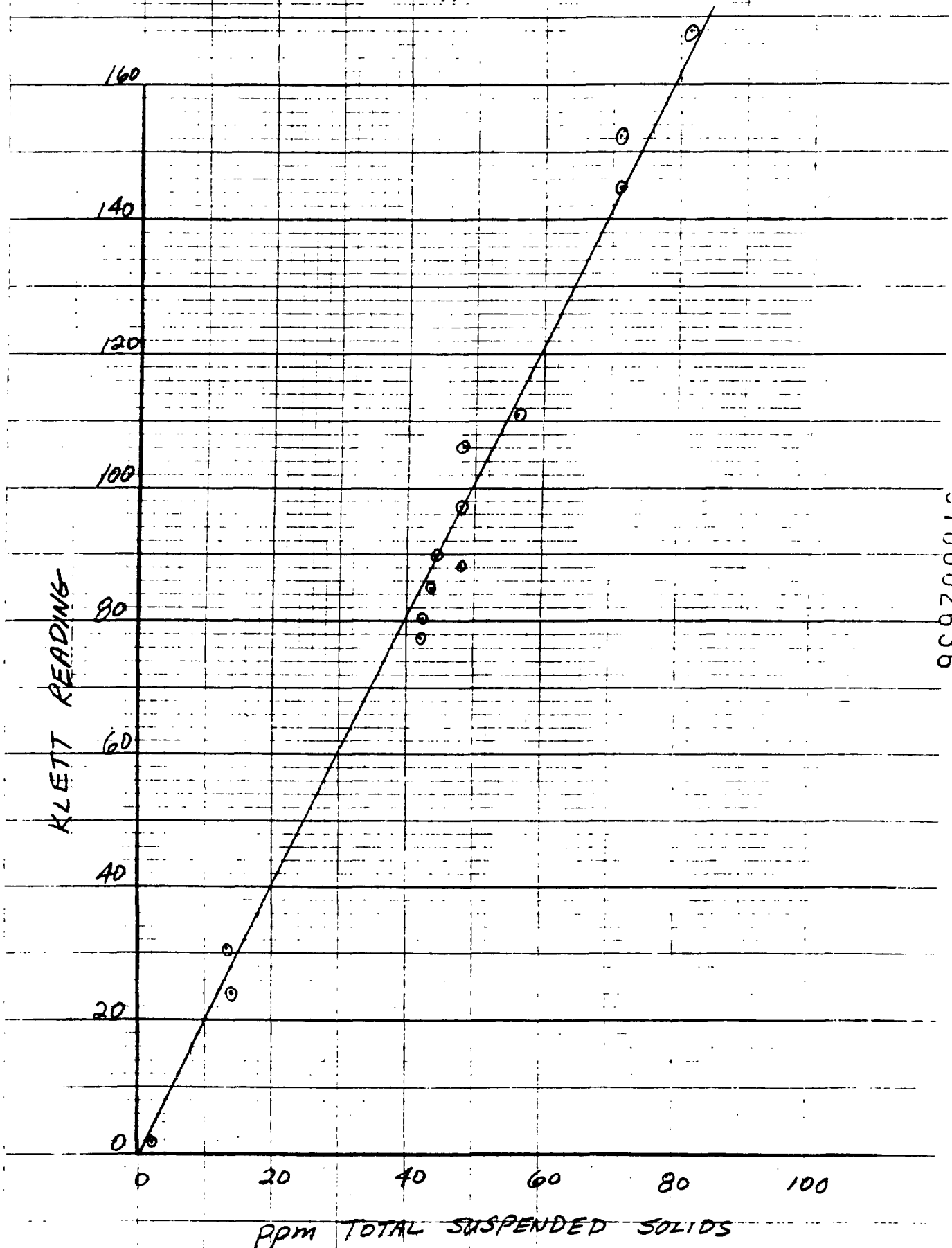


ST0002635
SS1 mds TSS

2/2/75

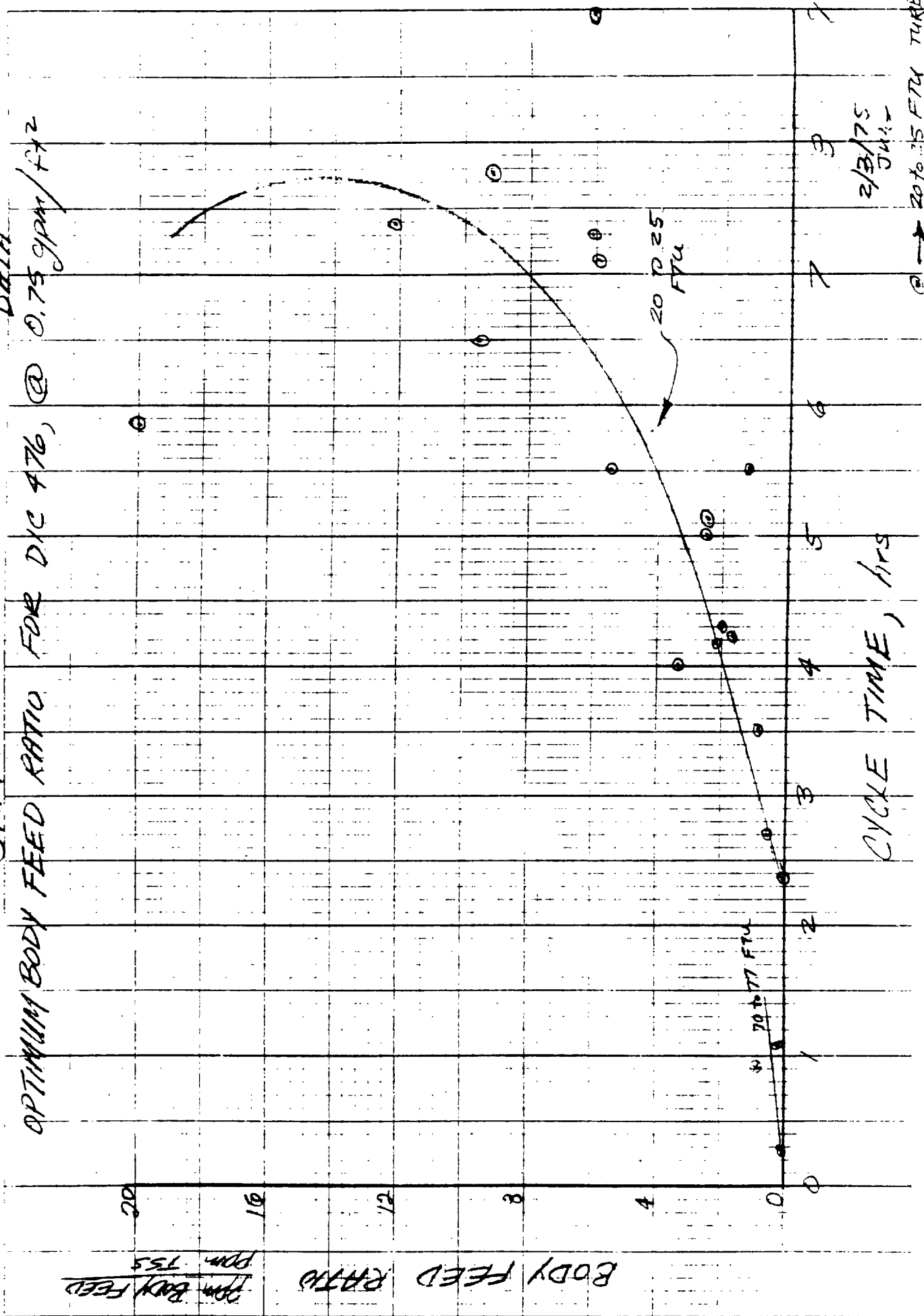
-22-
GRAPH #2

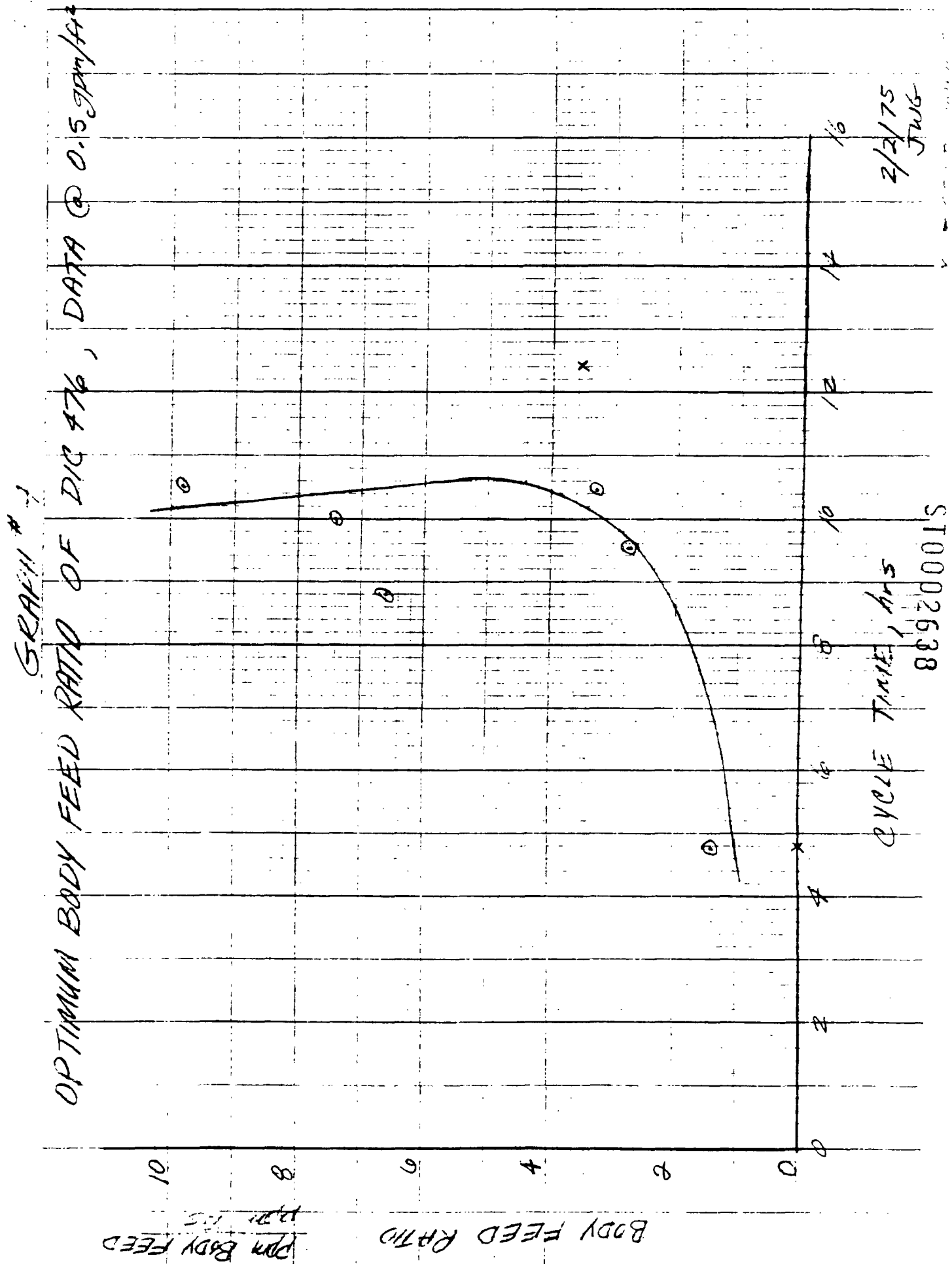
KLETT READING VS ppm TSS



510002636

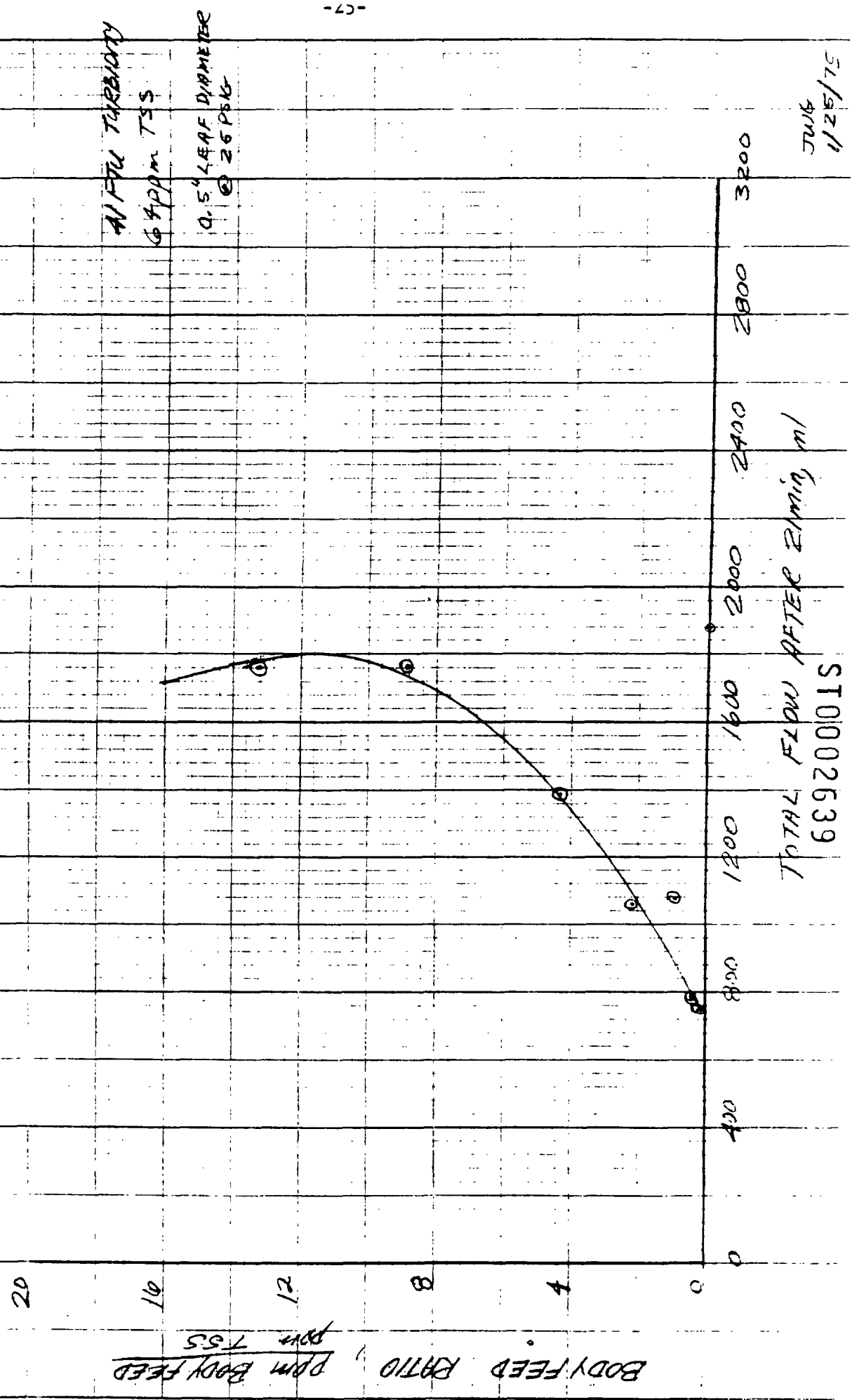
GRAPH # 3
OPTIMUM BODY FEED RATIO FOR DIC 476, @ 0.75 gpm/ft²





GRAPH #5

LAB FILTRATION OF TRENCH LIQUOR, OPTIMUM BODY FEED RATIO
FOR DIE 476



TOTAL FLOW AFTER RIMMING, ml

ST00002639

JUN 6 11 25/75

GRAPH #6

LAB FILTRATION OF TRENCH LIQUOR, OPTIMUM BODY FEED RATIO FOR D10 #76

BODY FEED RATIO, $\frac{\text{ppm BODY FEED}}{\text{ppm TSS}}$

20

10

5

3

1

0

0

400

800

1200

1600

2000

2400

2800

2400

3200

TOTAL FLOW AFTER 2/min, ml

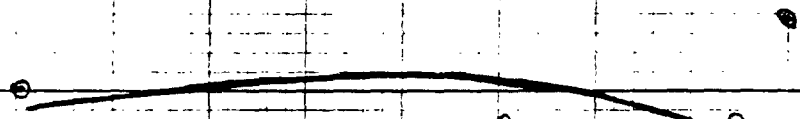
ST00002640

1/19/75
1/21/75

18 FTA TURBIDITY

28 ppm TSS

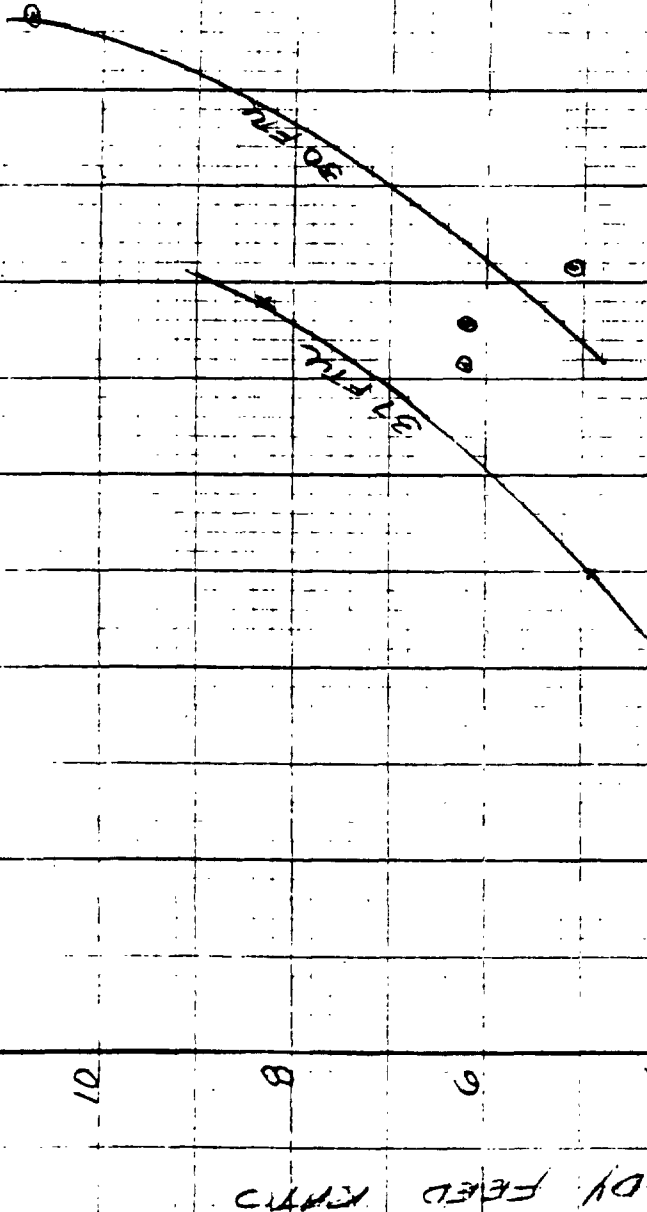
0.956" LEAF DIAMETER
@ 25 PSI



GRAPH #7

OPTIMUM BODY FEED RATIO OF DIC 436, DATA @ 0.75gpm/ft²

AFTER NEW CLOTHS INSTALLED



CYCLE TIME, hrs

ST0002641

2/3/75
JWG

46 0786

GRAPH #8

LAB FILTRATION OF TRENCH LIQUOR, OPTIMUM BODY FEED RATIO

FOR DIC 436

20

16

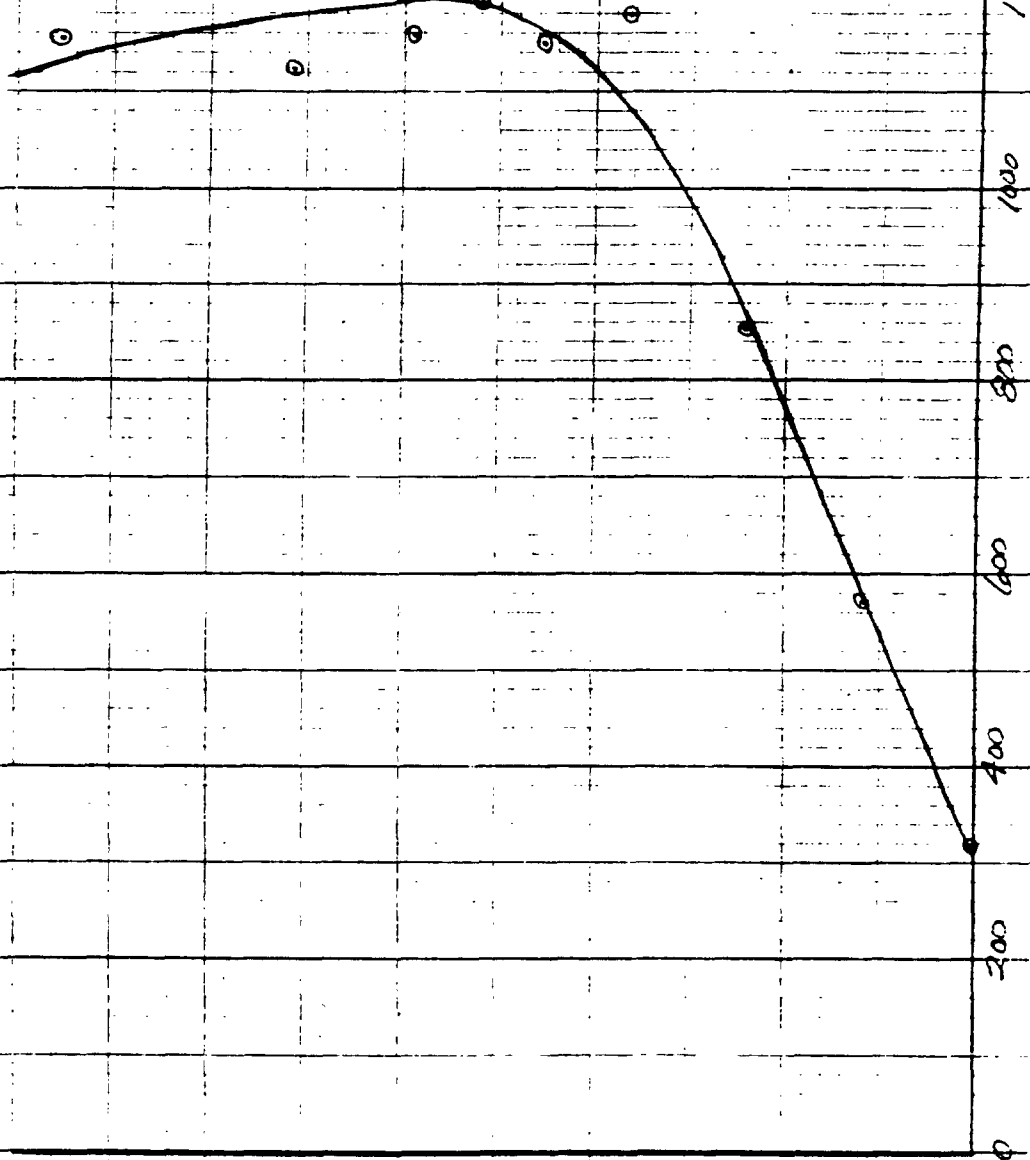
12

8

4

0

PPM BODY FEED
BODY FEED RATIO



GAPPA 755

0.956" I.E.A.F.
DIAMETER

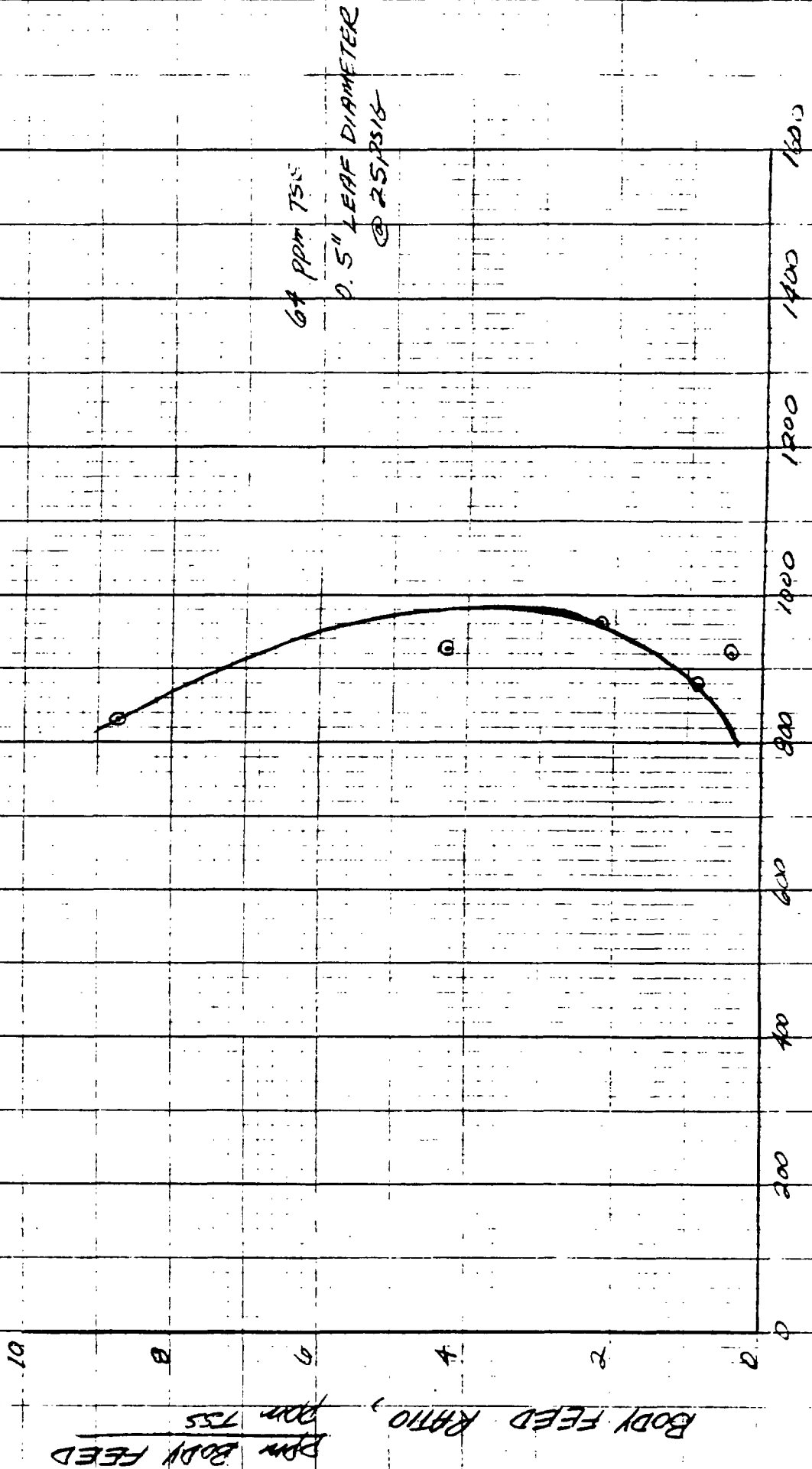
@ 25 PSI

TOTAL FLOW AFTER 21 min, ml
ST00002642
24700

11/11/75

GRAPH #9

LAB FILTRATION OF TRENCH LIQUOR, OPTIMUM BODY FEED
RATIO FOR DIC 436



64 ppm TSS

0.5" LEAF DIAMETER
@ 25 PSI

TOTAL FLOW AFTER 21 MIN, ml

ST0002643

1/25/75

GRAPH # 10

INLET TURBIDITY VS CYCLE TIME FOR DIC 476 @ 0.75 gpm/ft²
 @ VARIOUS BODY FEED RATIOS

100

80

60

40

20

0

INLET TURBIDITY, FTU

GENERAL CURVE

2

3

4

5

6

7

8

9

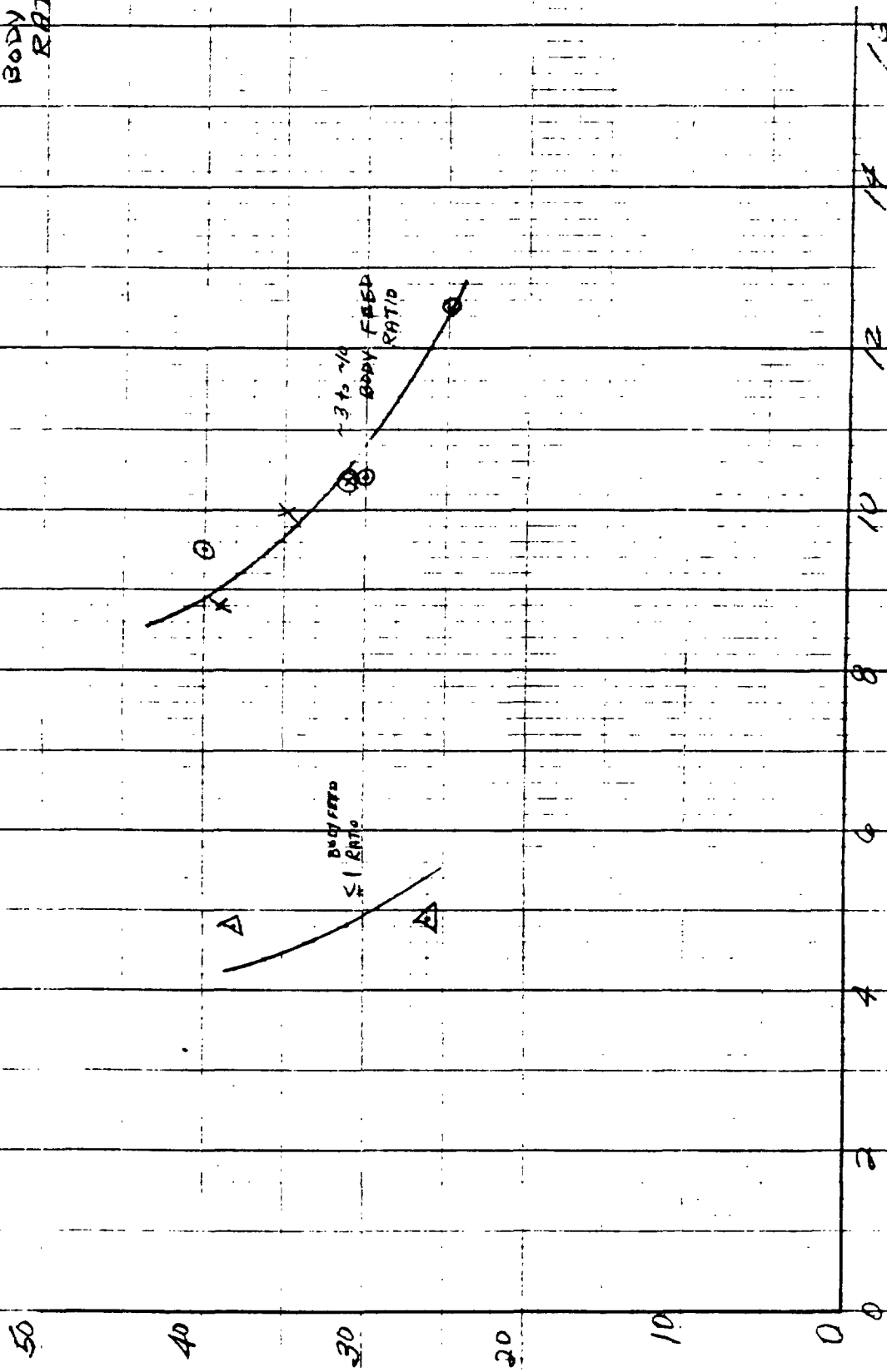
CYCLE TIME, HRS
 49200015
 2644
 10000

BODY FEED RATIOS
 DIC 476
 * < 1.0
 0 1.0
 x 2.0

46 3/50

GRAPH #11

INLET TURBIDITY VS CYCLE TIME FOR DIC 476 @ 0.5 gpm / ft²
 @ VARIOUS BODY FEED RATIOS



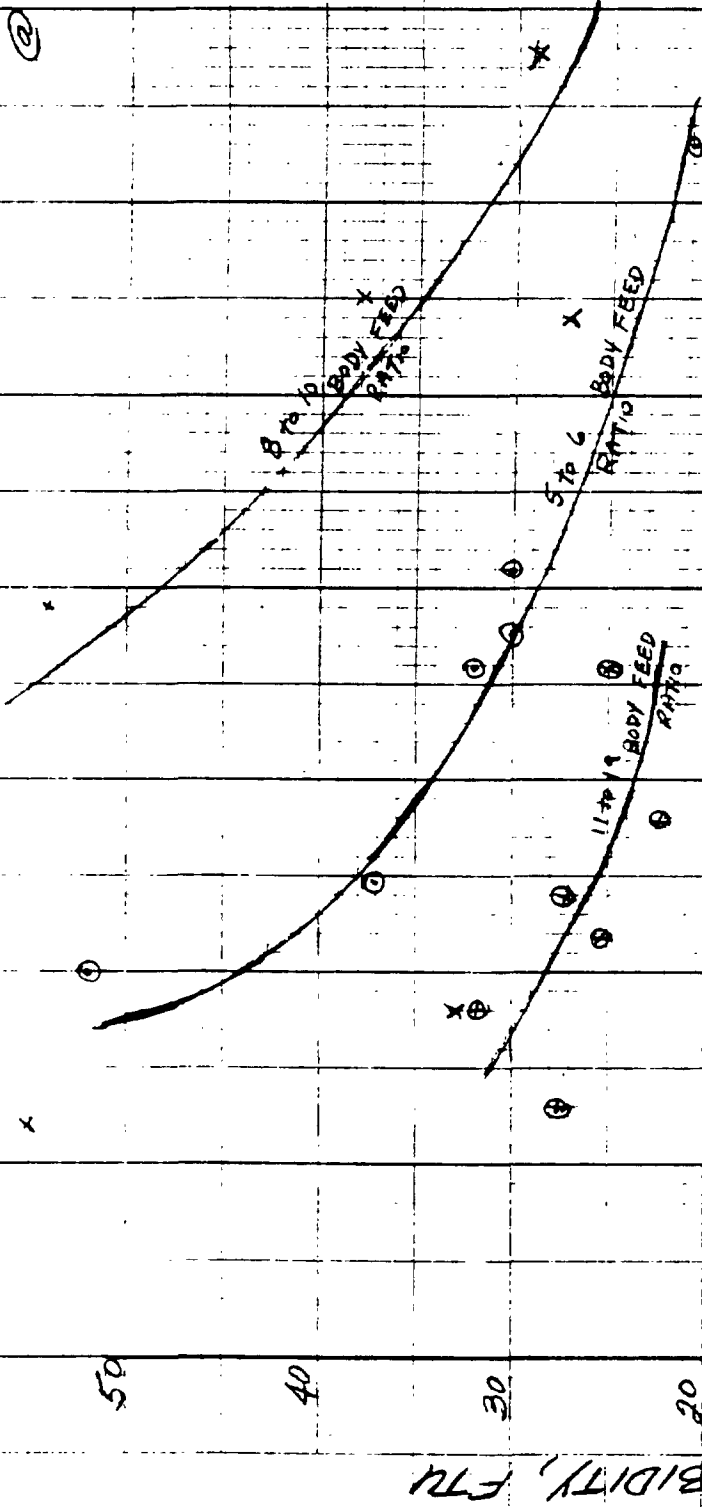
SI0002645
 549200000
 TIME 11:11

JWG
 2/12/75

GRAPH # 12

INLET TURBIDITY IS CYCLE TIME FOR DIC 436 @ 0.75 gpm/ft²

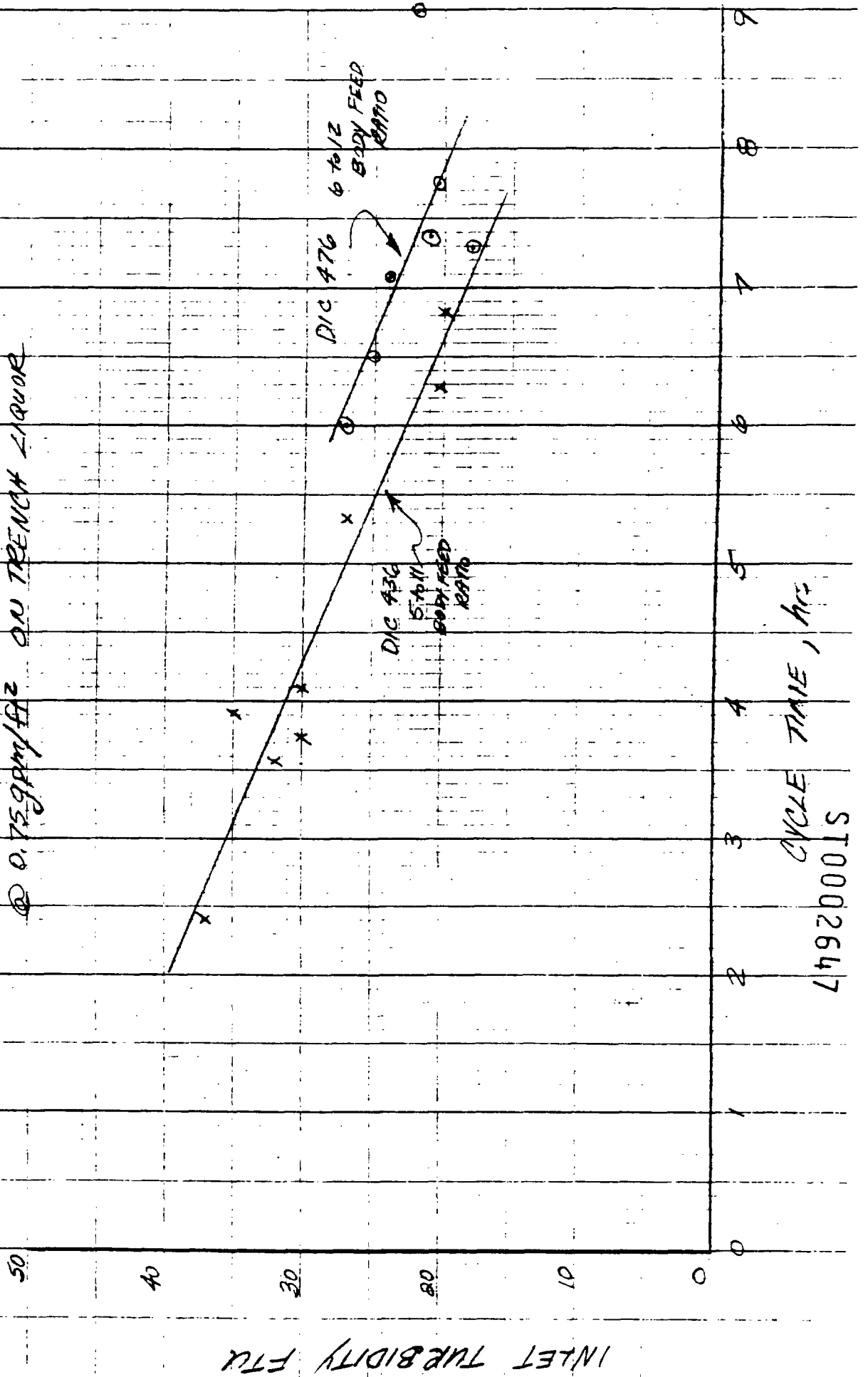
@ VARIOUS BODY FEED RATIOS



ST00002646
CYCLE TIME, hrs

2/3/75
JWG

GRAPH #13
INLET TURBIDITY VS CYCLE TIME FOR DIC 436
AND DIC 476 @ ~ SAME BODY FEED RATIO
@ 0.75 gpm/ft² ON TRENCH LIQUOR



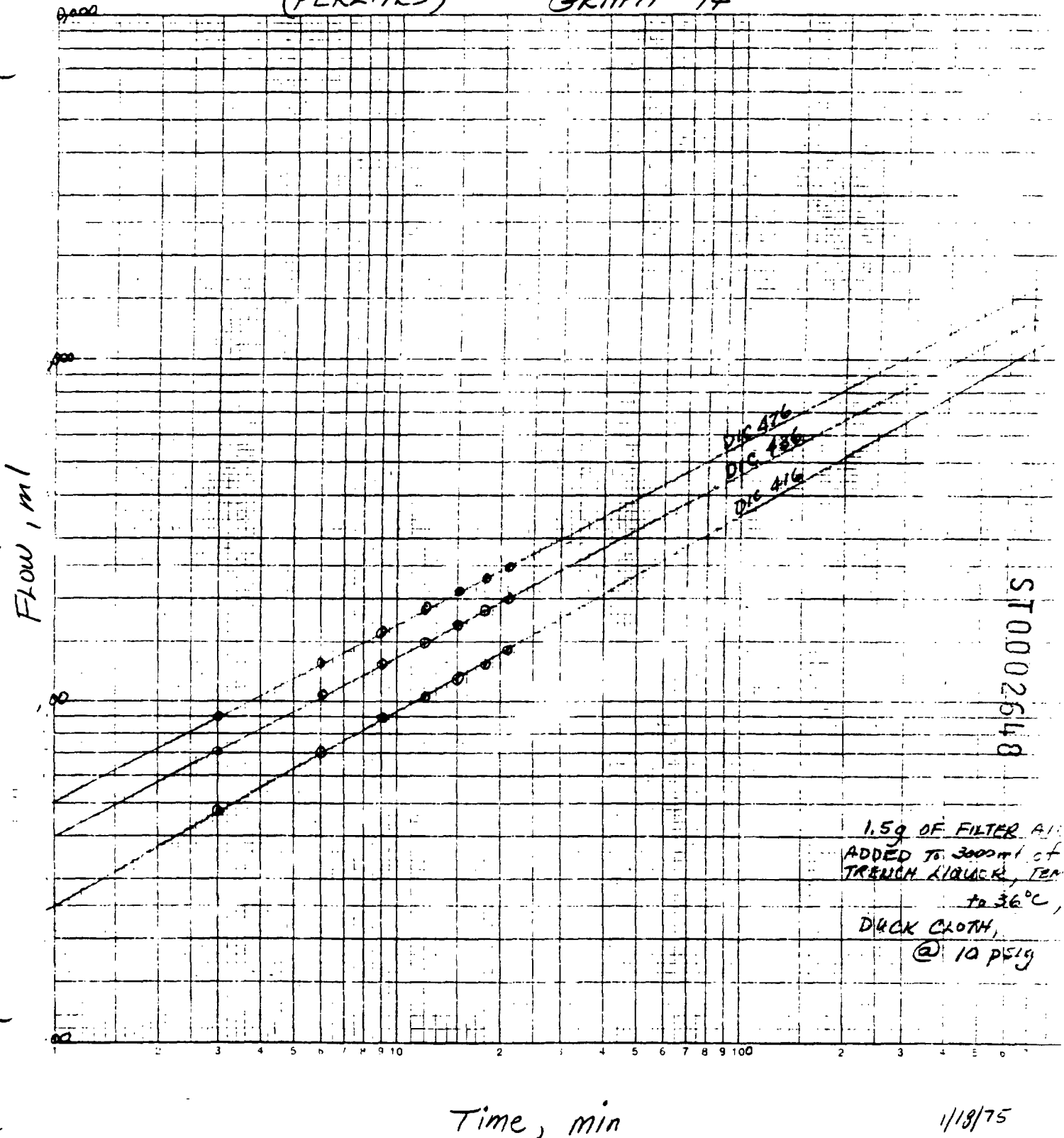
ST0002647

LAB FILTRATION

COMPARISON OF FILTER AIDS ON TRENCH LIQUOR
@ 10 psig

(PERLITES)

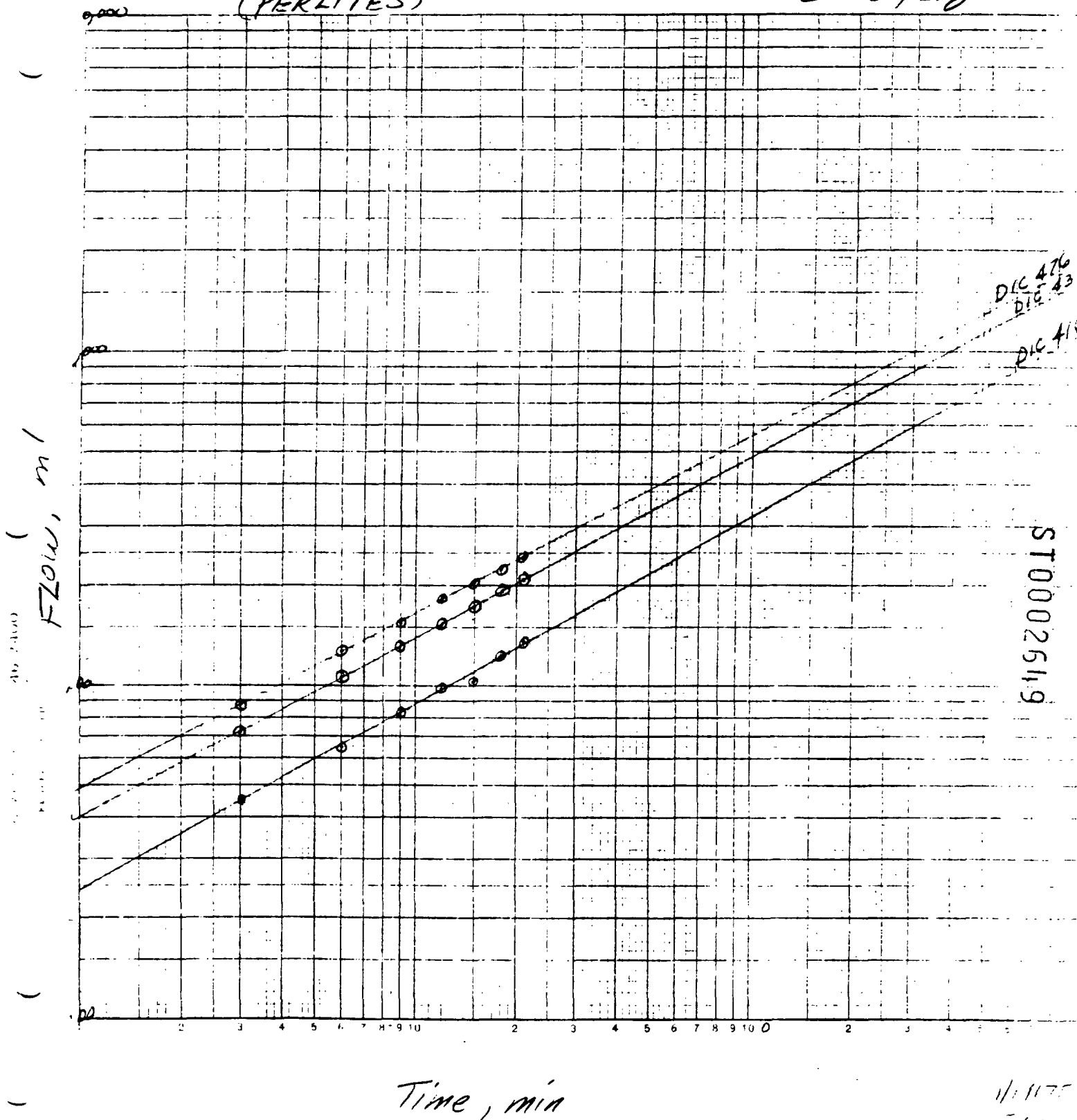
GRAPH # 14



1/18/75
JWG

GRAPH #15
LAB FILTRATION

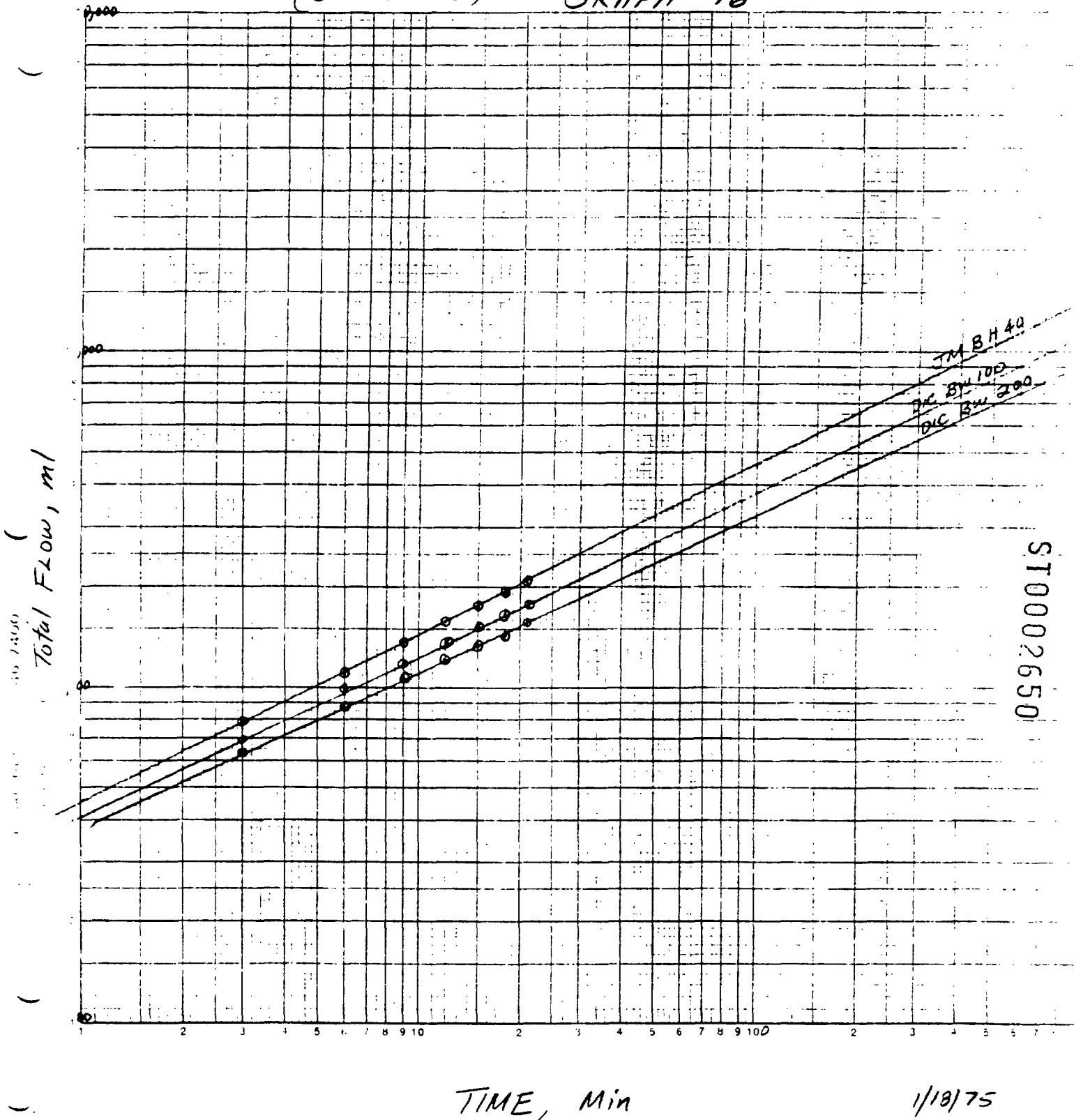
COMPARISON OF FILTER AIDS ON TRENCH LIQUOR
(PERLITES) @ 25 PSIG



LAB FILTRATION

COMPARISON OF FILTER AIDS ON TRENCH LIQUOR
@ 10 PSIG

(CELLULOSIC) GRAPH #16

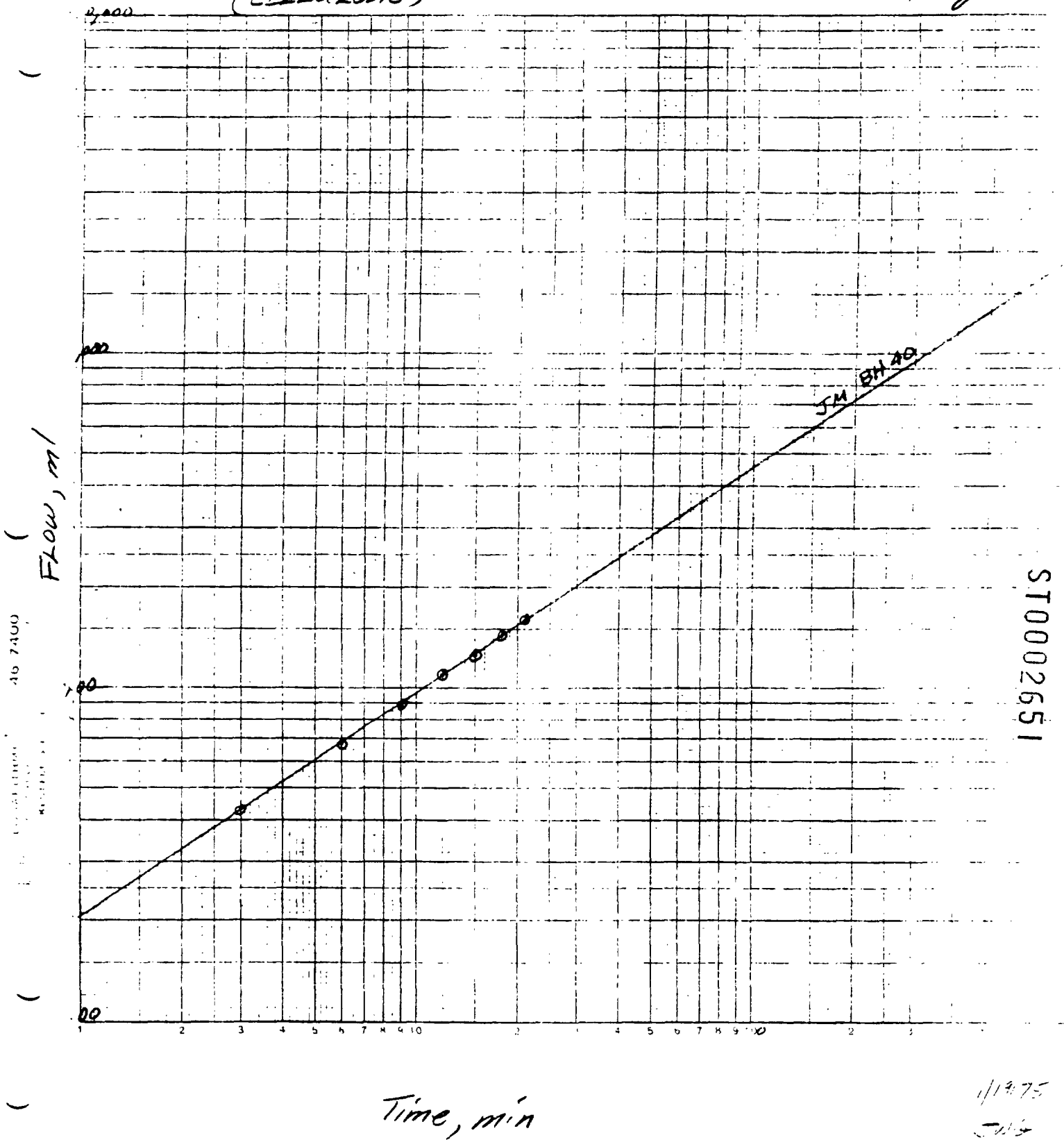


ST0002650

1/18/75
JWG

GRAPH #17
LAB FILTRATION

COMPARISON OF FILTER AIDS ON TRENCH LIQUOR
(CELLULOSIC) @ 25psig

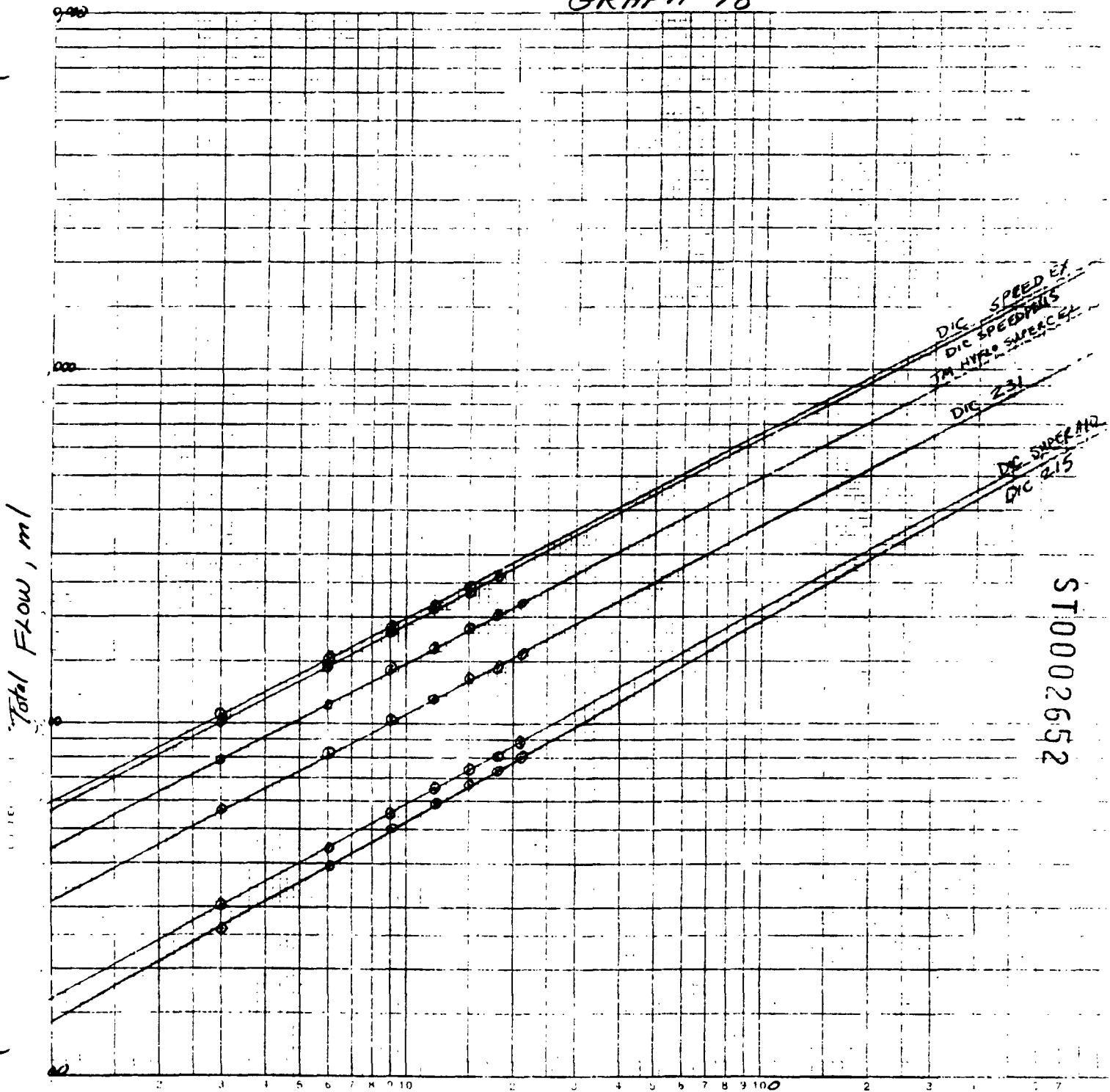


LAB FILTRATION

COMPARISON OF FILTER AIDS ON TRENCH LIQUOR
@ 10 PSI

(DIATOMITES)

GRAPH #18



ST00002652

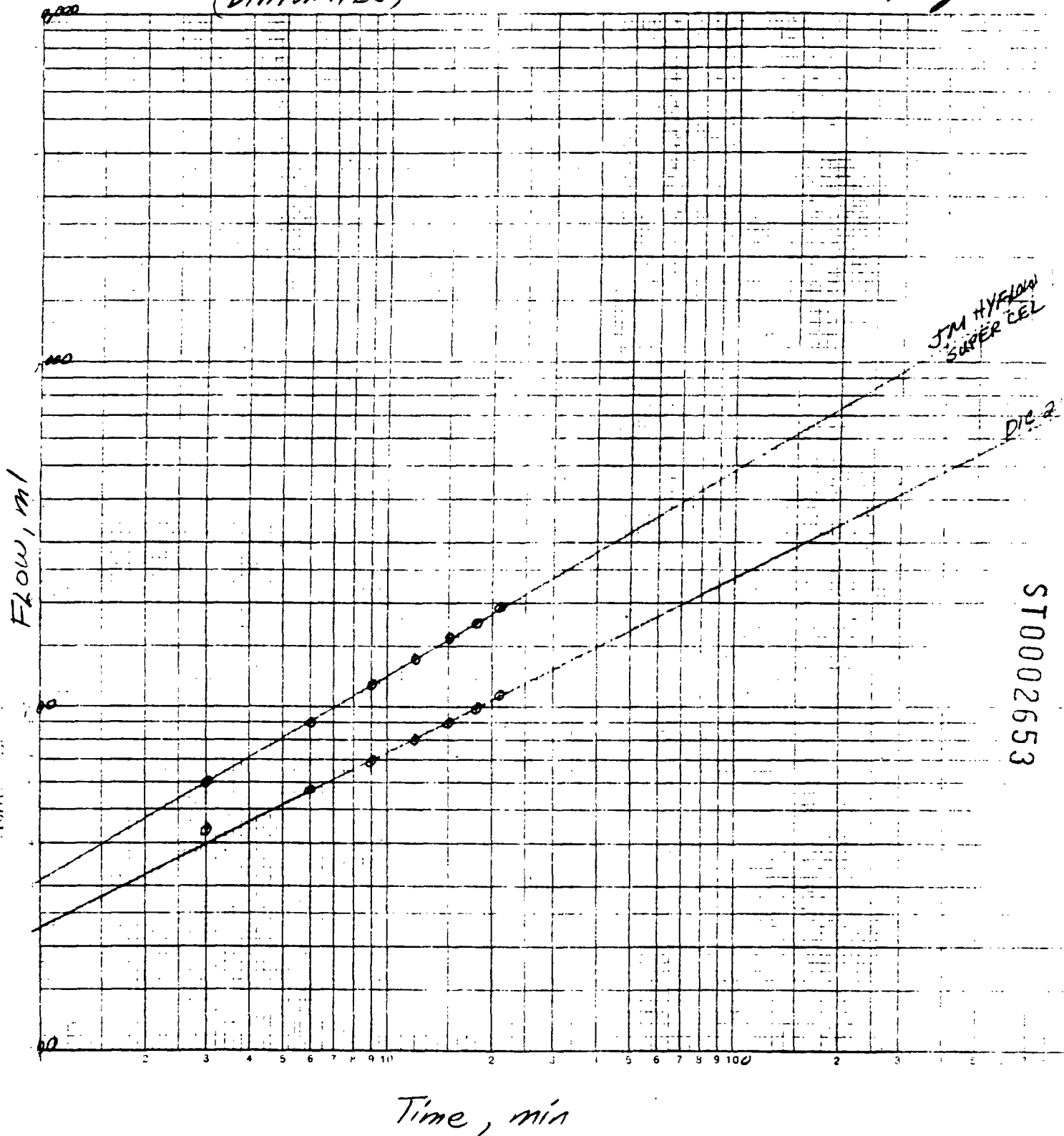
TIME, Min

1/18/75
JULG

-33-
LAB FILTRATION

GRAPH #19

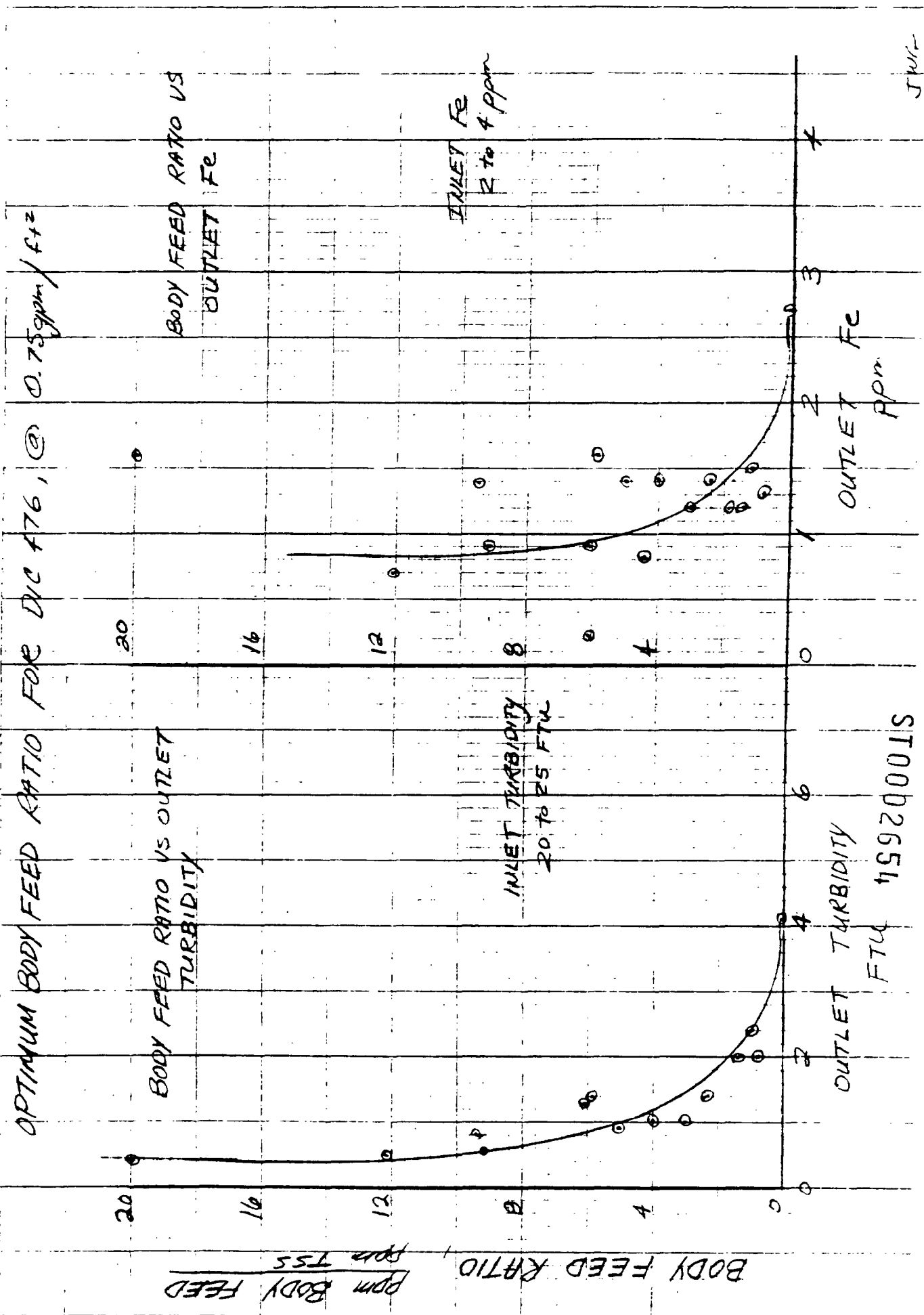
COMPARISON OF FILTER AIDS ON TRENCH LIQUOR
(DIATOMITES) @ 25PSIG



ST00002653

1/14/75
JH

GRAPH #20



JWIR
1/5/77

ST000b2654 4592000IS

LAB FILTRATION OF TRENCH LIQUOR,
RATIO FOR DIC #76

BODY FEED RATIO VS OUTLET TURBIDITY

BODY FEED RATIO VS OUTLET ppm Fe

INLET TURBIDITY
41 FTG

INLET Fe
8 ppm

OUTLET

FTU

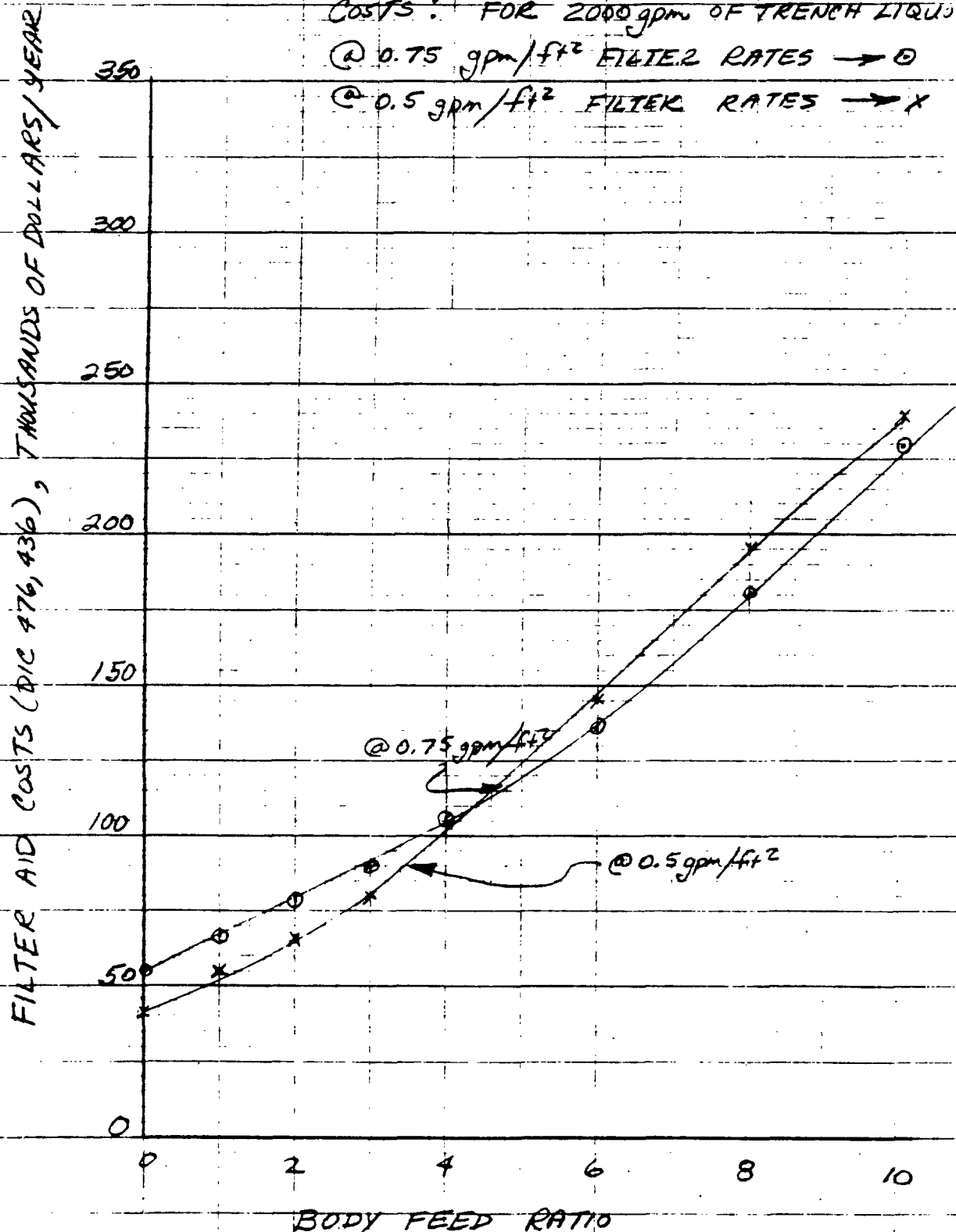
ST0002655

ST

3/25/11

GRAPH # 22

OPTIMUM BODY FEED RATIO FOR
PERLITES BASED ON FILTER AID
COSTS: FOR 2000 gpm OF TRENCH LIQUOR
@ 0.75 gpm/ft² FILTER RATES → ○
@ 0.5 gpm/ft² FILTER RATES → x



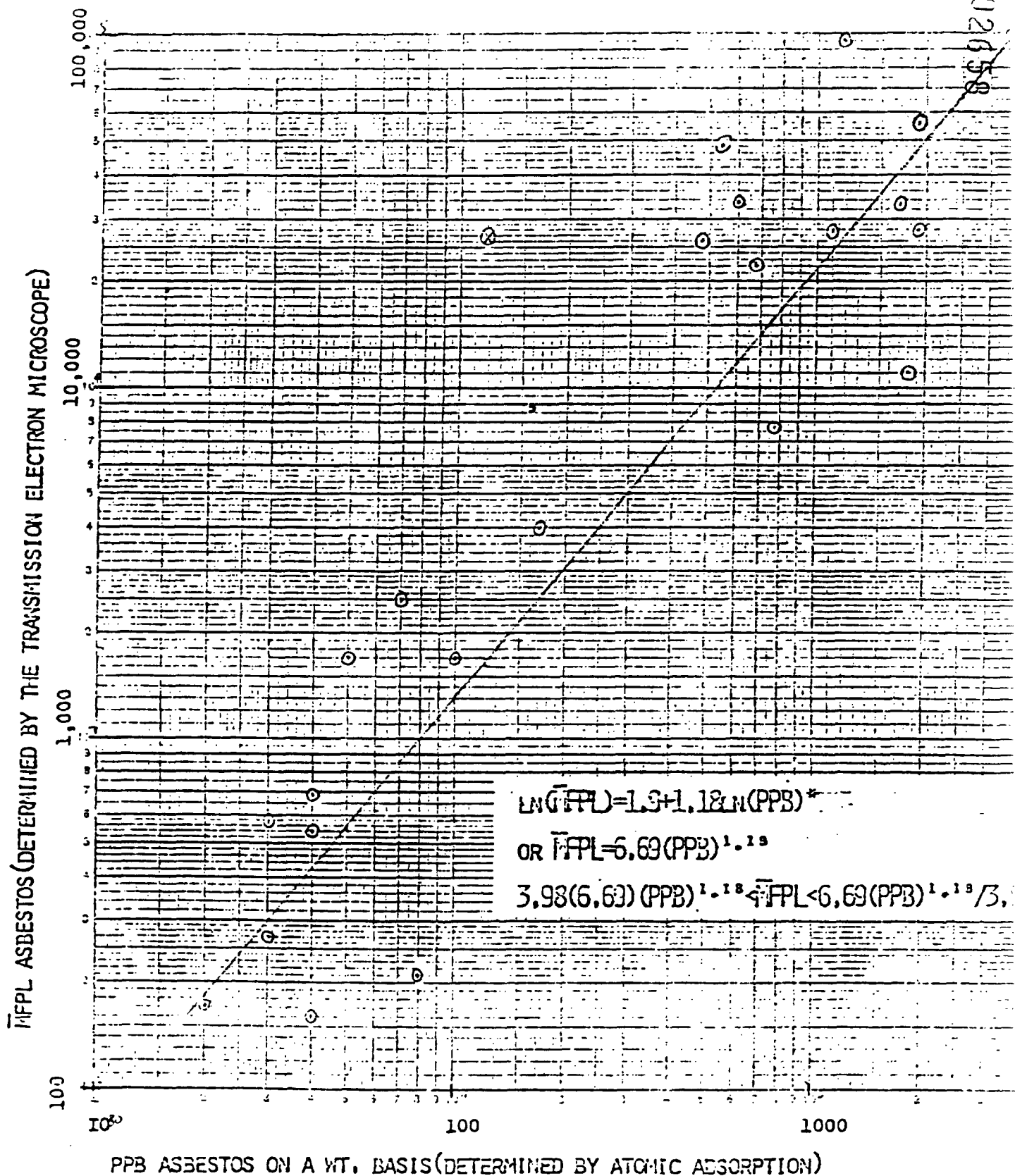
ST000026556

APPENDIX

1. A.A. to TEM Asbestos Correlation
2. Lab Filter Calculations and Conversion Factors

ST0002657

CONVERSION OF PPB ASBESTOS (WORK BY C. MINZE) TO MFPL (WORK BY L. MARTIN), THE LIQUID ANALYSED INCLUDES CELL EFFLUENT, BRINE, AND BIG-LAGOON WASTE WATER, THE LINEAR REGRESSION CORRELATION CO-EFFICIENT IS .07.



*LEAST SQUARES REGRESSION

BOMB FILTER LEAVES

<u>Diameter</u> <u>Inches</u>	<u>Area</u> <u>Sq. Inches</u>	<u>Area</u> <u>Sq. Feet</u>	<u>Conversion</u> <u>Factor ml.₂ to</u> <u>Gal./Ft.</u>
0.750	0.442	0.00307	0.0861
0.956	0.718	0.0050	0.0528
1.000	0.786	0.00545	0.0485
1.353	1.440	0.0100	0.0264
1.500	1.770	0.0123	0.0215
2.140	3.600	0.0250	0.0106
0.50	0.196	0.00136	0.1943

Amount of Filteraid to use = $\frac{\text{weight of liquor} \times \% \text{ Filteraid}}{100}$

<u>Dicalite</u> <u>Products</u>	<u>Relative Flowrate</u> <u>Rating</u>	<u>Competitive</u> <u>Offering</u>
Superaid	1	Filtercel
215	1	Filtercel
UF Grade	1	Celite 505
Speedflow	2	Standard Supercel
Sp. Speedflow	3	Celite 512
Speedplus	7	Hyflo Supercel
372	8	Celite 501
Speedex	10	Celite 503
4200	18	Celite 545

Formulas

$$(1) F_2 = F_1 \times \sqrt{\frac{P_2}{P_1}}$$

F_1 = Flow obtained during tests at P_1 on bomb filter

P_1 = Pressure used to obtain F_1

F_2 = New flow to be obtained at new pressure

P_2 = New pressure used to obtain new flow

$$(2) \text{Rate: Gallons/Ft}^2/\text{hr.} = \frac{\text{ml. Flow} \times \text{Leaf Conversion Factor}}{\text{Cycle length in Hours}}$$

$$(3) \text{Total Flow in ml.} = \frac{\text{Gallons/Ft}^2/\text{Hr.} \times \text{Cycle Length in Hours}}{\text{Leaf Conversion Factor}}$$

$$(4) \text{Cake Thickness} = \frac{21 \text{ min. Cake Thickness in inches} \times \text{desired cycle ml. flow}}{21 \text{ minute ml. flow}}$$

SI0002659