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INVESTIGATIONS ON OKLAHOMA CHATS

By

Homer Chalmers Kerr

and

August Francis Delaloye

A

THESIS

Submitted to the faculty of

THE SCHOOL OF MINES AND METALLURGY OF THE UNIVERSITY OF MISSOURI

in partial fulfillment of the work required for the

D E G R E E O F

BACHELOR OF SCIENCE IN MINE ENGINEERING

and

BACHELOR OF SCIENCE IN MINE ENGINEERING

Rolla, Mo.

1921

Approved by Chas. J. Clayton
Professor of Metallurgy and Ore Dressing.

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INVESTIGATIONS ON OKLAHOMA CHATS

Introduction

That the tailings piles of the Joplin and the Oklahoma zinc mining fields contain zinc in commercial quantities is a known fact. Realizing this fact, a number of experiments were performed to determine whether or not this zinc could be extracted.

The chats for this work were obtained from the Fort Worth Mill at Pitcher, Oklahoma. They were received in two lots, one being a sample of the tailings from the rougher jigs, and the other a sample of the tailings from the tables. The chats from the rougher jigs were sampled and assayed. The assay showed them to contain 2.85% zinc, 5.92% iron, 1.40% lime, 80.0% insoluble.

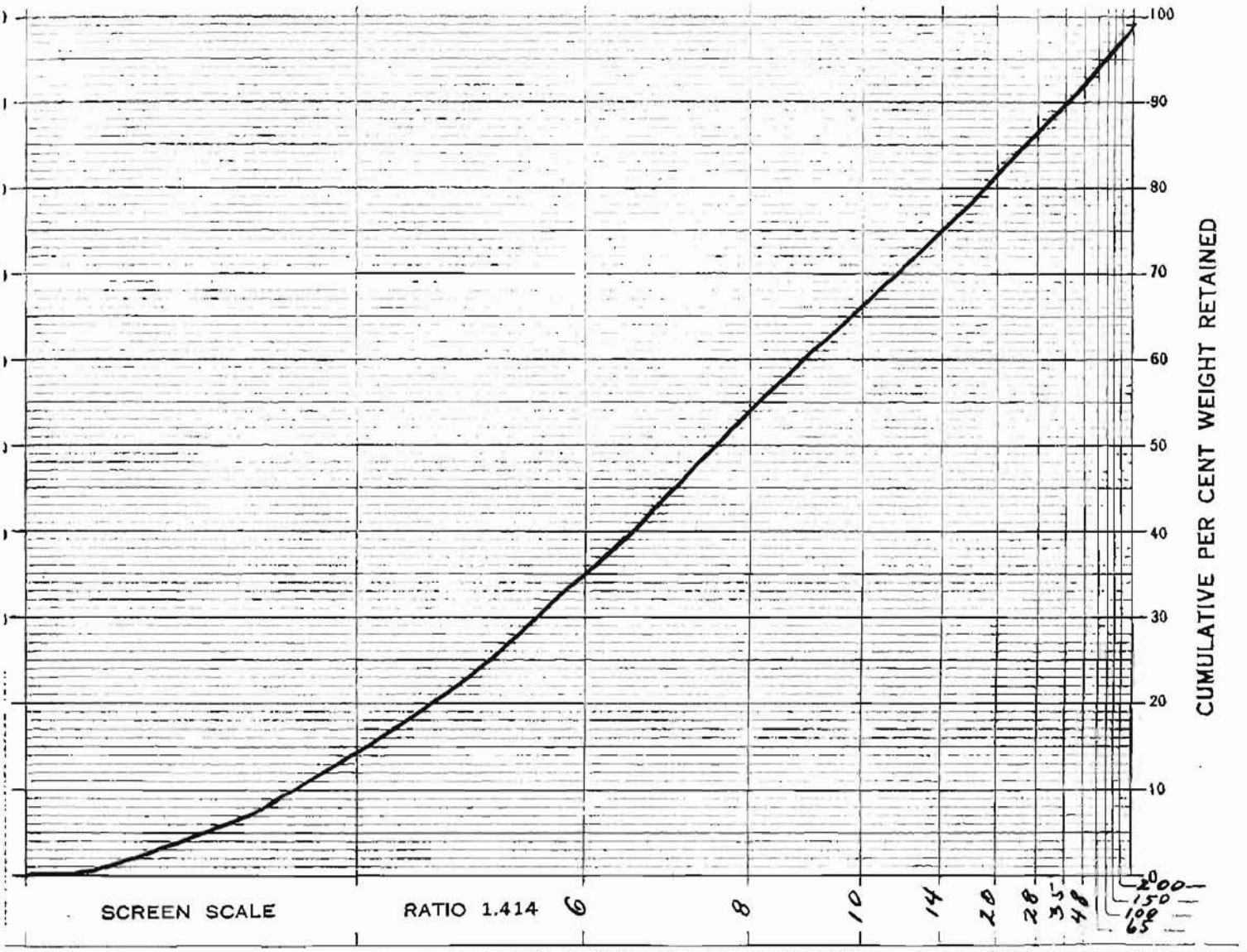
A screen analysis of these chats is shown on page 3. By studying the material which remained on each screen, it was found that all the blende was broken free when the material passed a 65-mesh screen. It was then decided to find out what per cent, by weight, of free gangue would be found on the larger screens. By actually separating the grains of free gangue from the blende and the particles which contained some zinc, results were arrived at as shown on the screen analysis on page 3. From this screen analysis, one can see that 76.4% of the total weights of the chats remained on the 14-mesh screen. By combining these results, it was found that 55% of the chats on screen No. 14 contained no zinc. After arriving at these re-

sults an attempt was made to use the jigs in order that a clean tailing might be obtained, thus eliminating much of the material before fine grinding.

The Tyler Standard Screen Scale

Cumulative Direct Diagram of Screen Analysis on Sample of Material as received

Name _____ Date _____



te the Screen hed through also First tetaining Screen	SCREEN SCALE RATIO 1.414 Openings Inches	Openings Millimeters	Mesh	Diameter Wire Inches	Sample Weights	Per Cent	Per Cent Cumulative Weights	% Zn.	% Fe	% Free Chert
	1.050	26.67		.149						
	.742	18.86		.135						
	.526	13.33		.105						
	.371	9.423		.092						
	.263	6.680	3	.070						
	.185	4.699	4	.065						
on	.131	3.327	6	.036	109.2	36.6	36.6	2.24	5.2	90
	.093	2.362	8	.032	50.0	16.2	52.8	2.35	3.3	70
	.065	1.651	10	.035	42.5	14.3	67.1	2.51	4.3	70
	.046	1.168	14	.025	27.6	9.3	76.4	2.45	4.4	62
	.0328	.833	20	.0172	15.5	5.2	81.6	2.35	4.2	
	.0232	.589	28	.0125	14.9	5.0	86.6	2.03	3.6	
	.0164	.417	35	.0122	9.1	3.1	89.7	1.81	3.6	
	.0116	.295	48	.0092	6.1	2.1	91.8	1.81	3.8	
	.0082	.208	65	.0072	4.2	1.5	93.3	1.87	3.0	
	.0058	.147	100	.0042	3.6	1.3	94.6	2.88	.4	
	.0041	.104	150	.0038	2.7	1.2	95.8	5.81	.5	
	.0029	.074	200	.0021	1.8	0.9	96.7	9.65	.5	
thru	.0029	.074	200	.0021	8.4	2.9	99.6	15.88	1.8	
				Totals.	285.7	99.6				

THE W. S. TYLER COMPANY, CLEVELAND, OHIO

Experiment One

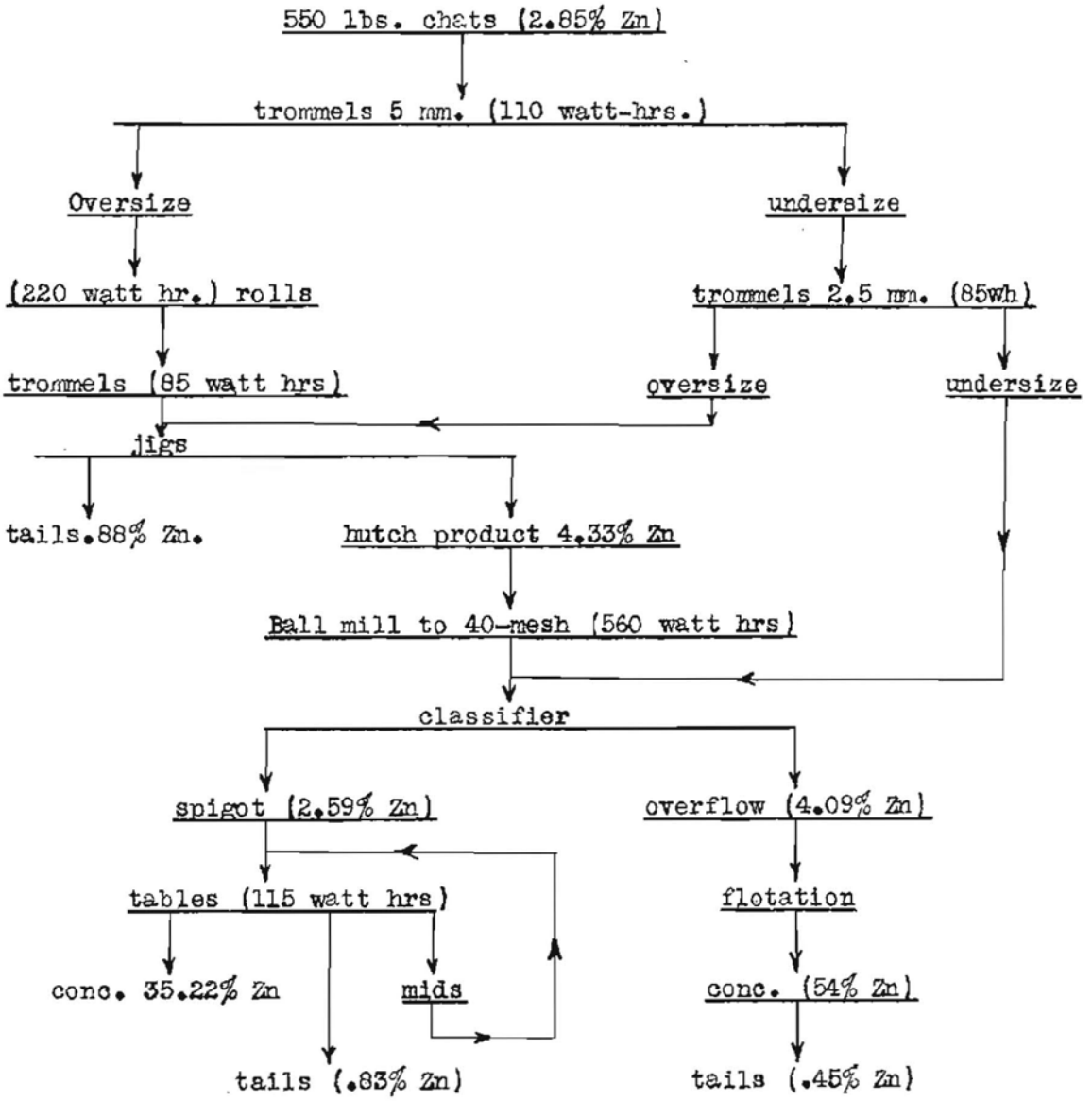
For the first run 550 lbs. of chats was weighed up and trommeled. Two revolving trommels were used, one having a 5 mm. opening and the other a 2.5 mm. opening. The material which remained on the 5 mm. trommel was passed through fine rolls and retrommeled. The material which then remained on the 5 mm. trommel was jigged with the material which passed through the 5 mm. trommel and that which remained on the 2.5 mm. trommel.

No attempt was made to obtain a concentrate from the jigs, the idea being simply to obtain a clean tailing. The material from the hutch was then ground in the ball mill and classified in the hydraulic classifier. The material which passed through the 2.5 mm. trommel was classified through the same classifier as the material obtained from the ball mill. Two products resulted; namely, a spigot product and an overflow product. Concentration of the spigot product was obtained by means of tables, and that of the overflow by means of flotation. A flow sheet with results for this method will be found on page 5.

These figures give the extraction of the material which was tabled as 52% and that which was floated 95%, or a total extraction of 78%. This figure would give a total of 12.23 lbs. of zinc recovered from the 550 lbs. of chats treated.

Estimating the cost of electrical power to be $0.02 per KW hour, the total cost for power would be $0.037 per 550 lbs. treated, or $0.1245 per ton of chats treated. This would make the cost of power equal to .302 cents per pound of zinc recovered.

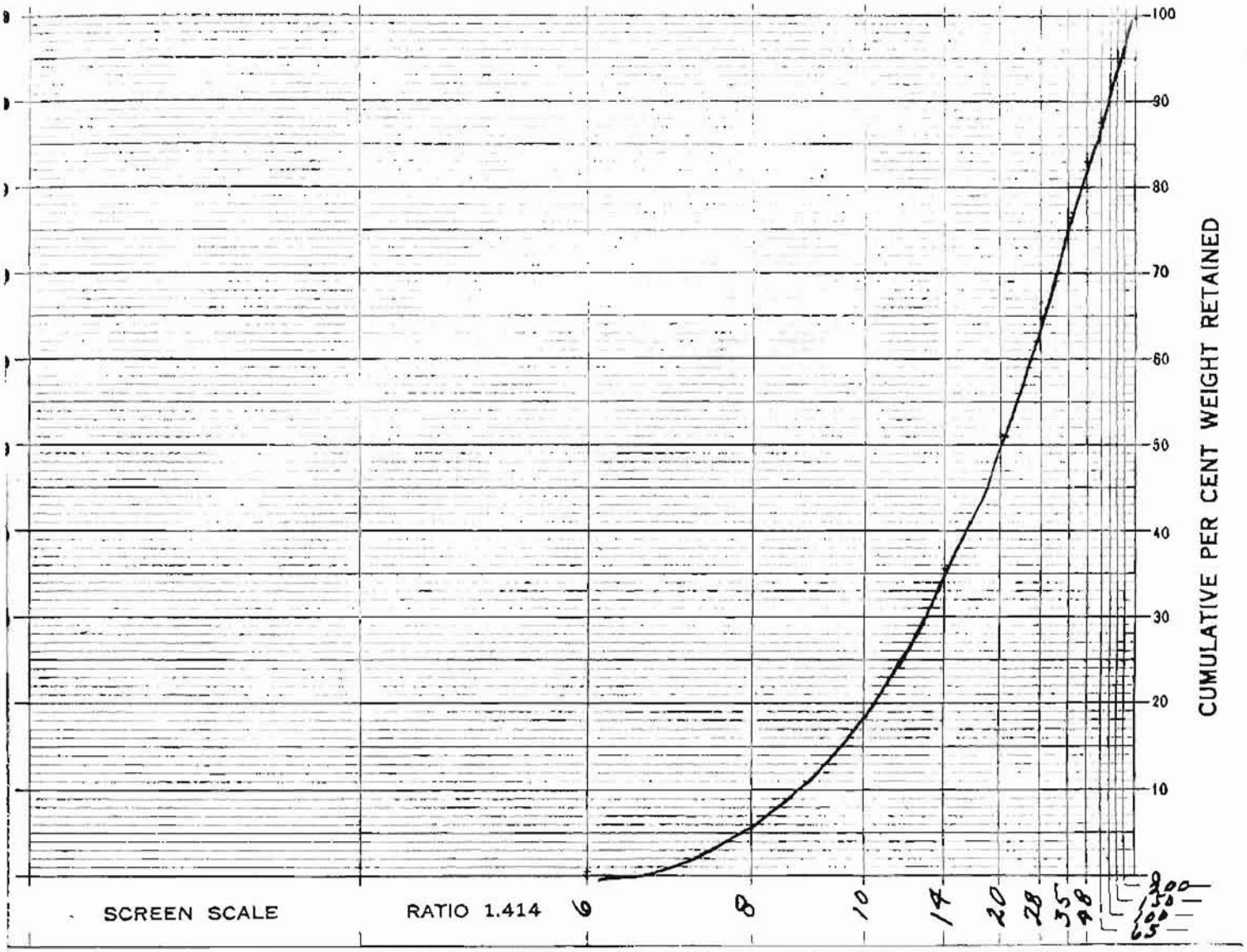
Flow Sheet for Experiment No. One.



The Tyler Standard Screen Scale

Cumulative Direct Diagram of Screen Analysis on Sample of *Material from rolls.*

Name _____ Date _____



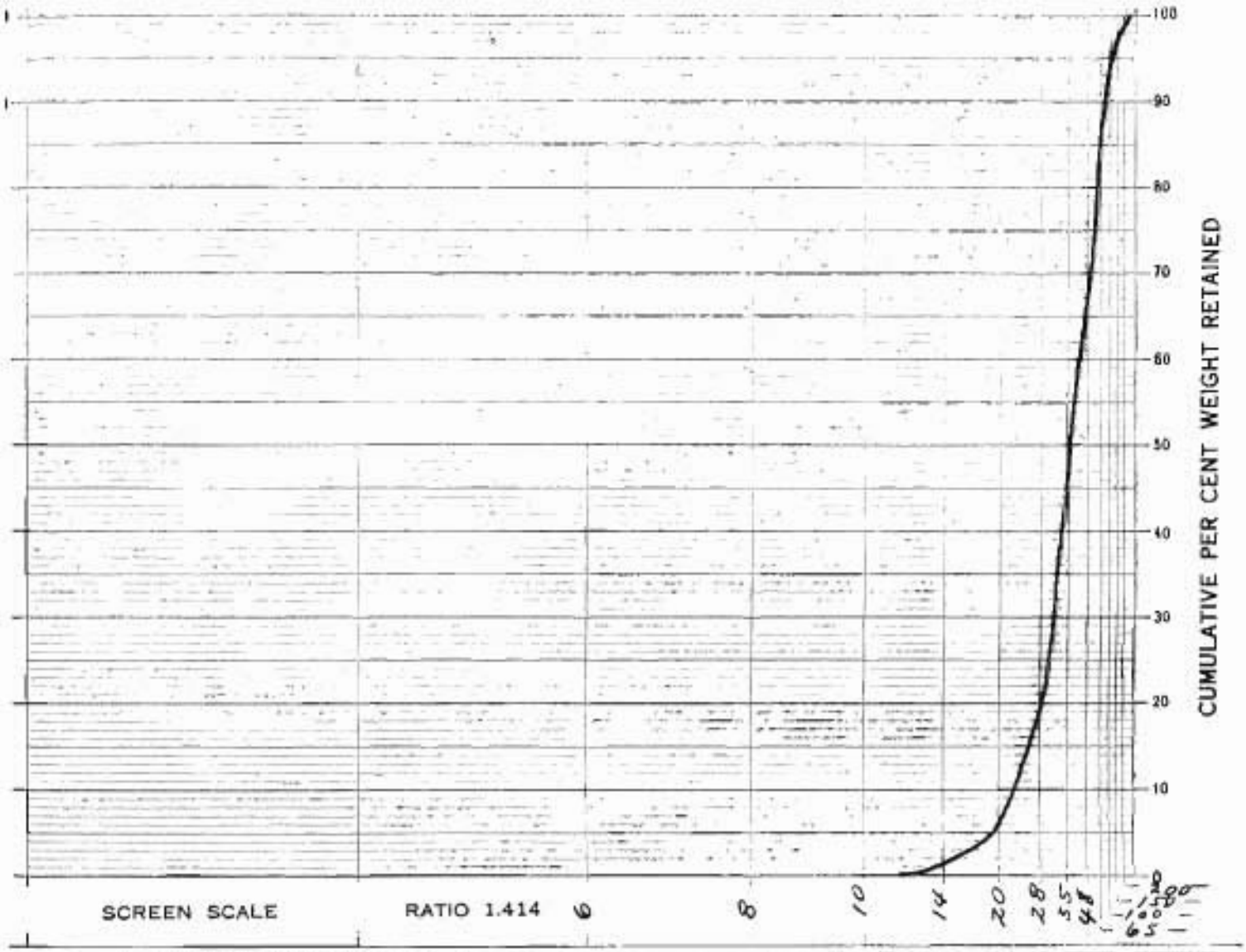
...e the Screen ...hed through ...l also First ...etaining Screen	SCREEN SCALE RATIO 1.414 Openings Inches	Openings Millimeters	Mesh	Diameter Wire Inches	Sample Weights	Per Cent	Per Cent Cumulative Weights
	1.050	26.67		.149	Gms.		
	.742	18.85		.135			
	.525	13.33		.105	300 gm		
	.371	9.423		.092	sample		
	.263	6.680	3	.070			
	.185	4.699	4	.065			
on	.131	3.327	6	.036	1.90	0.6	0.6
"	.093	2.362	8	.032	13.90	4.6	5.2
	.065	1.651	10	.035	40.35	13.4	18.6
	.046	1.168	14	.025	50.63	16.8	35.4
	.0328	.833	20	.0172	46.70	15.6	51.0
	.0232	.589	28	.0126	46.73	15.6	66.6
	.0164	.417	35	.0122	29.40	9.8	76.4
	.0116	.295	48	.0092	20.05	6.6	83.0
	.0082	.208	65	.0072	14.24	4.7	87.7
	.0058	.147	100	.0042	11.75	3.9	91.6
	.0041	.104	150	.0026	8.92	2.9	94.5
	.0029	.074	200	.0021	3.80	1.2	95.7
thru	.0029	.074	200	.0021	11.60	3.8	99.5
				Totals.	299.97	99.5	

THE W. S. TYLER COMPANY, CLEVELAND, OHIO

The Tyler Standard Screen Scale

Cumulative Direct Diagram of Screen Analysis on Sample of Spigot Product.

Name _____ Date _____



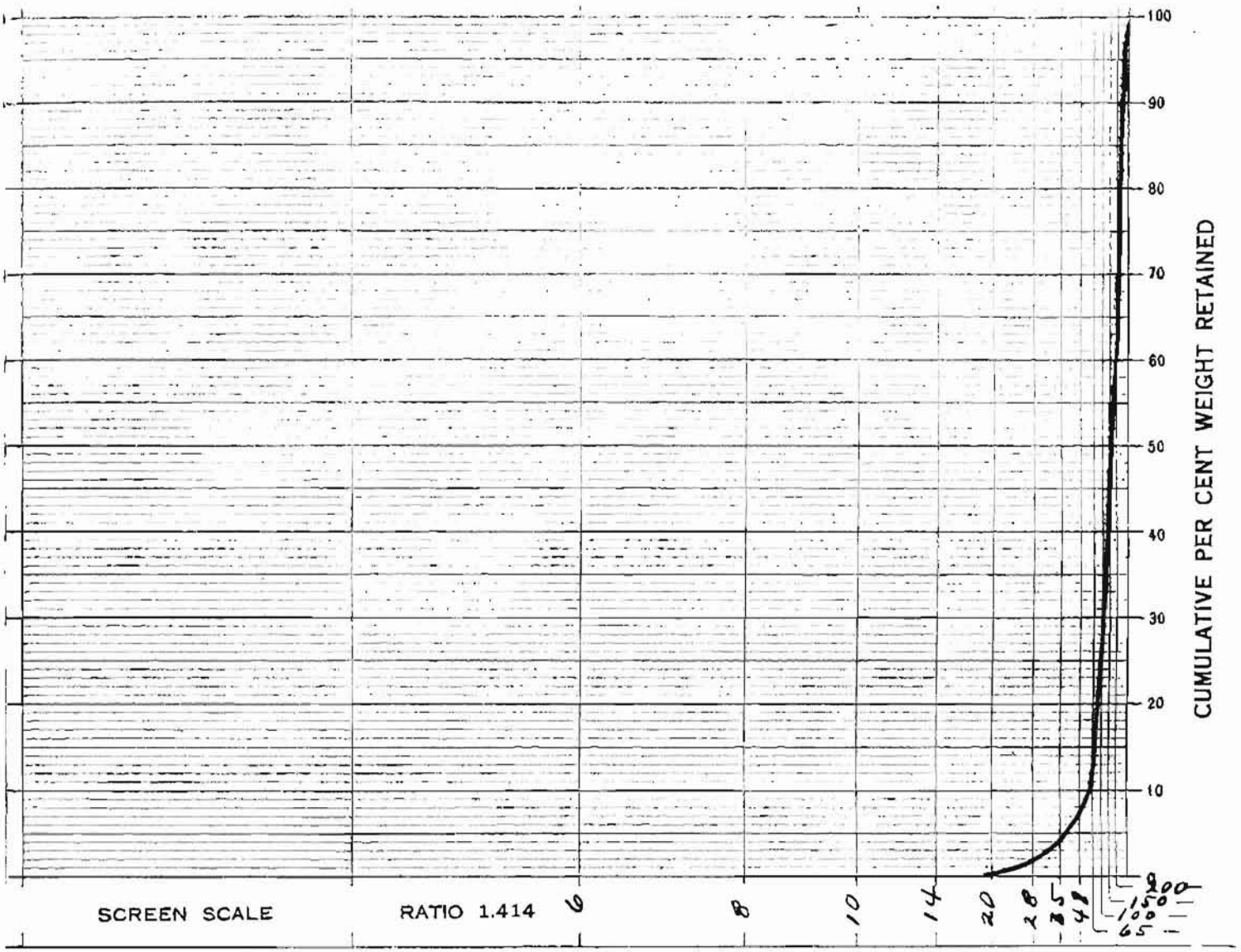
In the Screen and through also First retaining Screen	SCREEN SCALE RATIO 1.414 Openings Inches	Openings Millimeters	Mesh	Diameter Wire Inches	Sample Weights	Per Cent	Per Cent Cumulative Weights	% Zn
	1.050	26.67		.148	Grms.			
	.742	18.85		.135				
	.525	13.33		.105				
	.371	9.423		.092	300 gm sample			
	.263	6.680	3	.070				
	.185	4.699	4	.065				
	.131	3.327	6	.036				
	.093	2.362	8	.032				
on	.065	1.651	10	.035	0.2	0.1	0.1	—
	.046	1.168	14	.025	1.6	0.5	0.6	—
	.0328	.833	20	.0172	13.4	9.5	5.1	1.8
	.0232	.589	28	.0125	55.2	11.4	23.5	1.5
	.0164	.417	35	.0122	61.6	30.5	44.0	1.4
	.0116	.295	48	.0092	61.1	20.4	64.4	1.6
	.0082	.208	65	.0072	51.5	17.1	81.5	2.0
	.0058	.147	100	.0042	40.2	13.4	94.9	3.0
	.0041	.104	150	.0026	11.7	3.9	98.8	11.4
	.0029	.074	200	.0021	1.6	0.5	99.3	23.8
thru	.0029	.074	200	.0021	1.1	0.1	99.4	—
				Totals	299.2	99.4		

THE W. S. TYLER COMPANY, CLEVELAND, OHIO

The Tyler Standard Screen Scale

Cumulative Direct Diagram of Screen Analysis on Sample of Slimes

Name _____ Date _____



e the Screen ed through also First etaining Screen	SCREEN SCALE RATIO 1.414 Openings Inches	Openings Millimeters	Mesh	Diameter Wire Inches	Sample Weights	Per Cent	Per Cent Cumulative Weights		% In.
					Gms.				
	1.050	26.67		.149					
	.742	18.85		.135					
	.525	13.33		.106	300 gm. sample				
	.371	9.423		.092					
	.263	6.680	3	.070					
	.185	4.699	4	.065					
	.131	3.327	6	.036					
	.093	2.362	8	.032					
	.065	1.651	10	.035					
On	.048	1.168	14	.025	0.3	0.1	0.1		—
	.0328	.833	20	.0172	0.9	0.3	0.4		—
	.0232	.589	28	.0125	4.3	1.4	1.8		1.6
	.0164	.417	35	.0122	6.9	2.3	4.1		1.6
	.0116	.295	48	.0093	7.3	2.4	6.5		1.8
	.0082	.208	65	.0072	10.4	3.5	10.0		2.6
	.0058	.147	100	.0042	31.9	10.6	20.6		2.1
	.0041	.104	150	.0026	70.9	23.6	44.2		3.7
thru	.0029	.074	200	.0021	96.7	32.2	76.4		7.7
	.0029	.074	200	.0021	69.9	23.3	99.7		3.3
				Totals.	299.5	99.7			

THE W. S. TYLER COMPANY, CLEVELAND, OHIO

Experiment Two

For the runs which followed, it was decided to eliminate the jigs and grind the chats as they were received, in the ball mill. The question to be considered on this method was whether or not the material (the gangue being hard chert) would be too hard to grind, thus causing a consumption of too much power and too great a wear on the balls in the ball mill. For this method the chats were treated as follows: 300 lbs of the chats was weighed up and ground in the ball mill and classified, the spigot product being treated on the tables and the over-flow by flotation. A flow sheet of this operation with results is found on page 11.

These results give a table extraction of 38%. With a flotation extraction of 93%,we obtained a total extraction of 60%. From this figure, a recovery of 8.93 lbs. per 300 lbs. of chats treated was realized. This gives a total recovery of 34.2 lbs. of zinc per ton of chats treated.

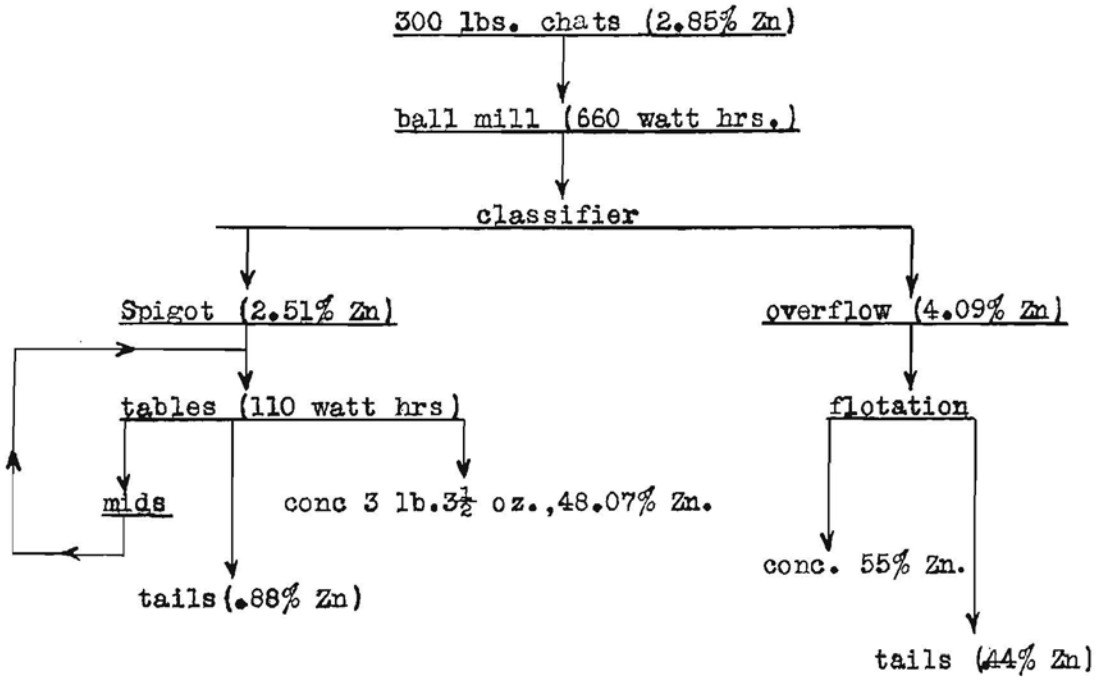
Again estimating the cost of power to be two cents per KW hour, a total cost for power amounts to .299 cents per pound of zinc recovered. The total loss of iron on the ball mill for this method was found to be about 4 lbs. per ton of chats treated.

Experiment Three

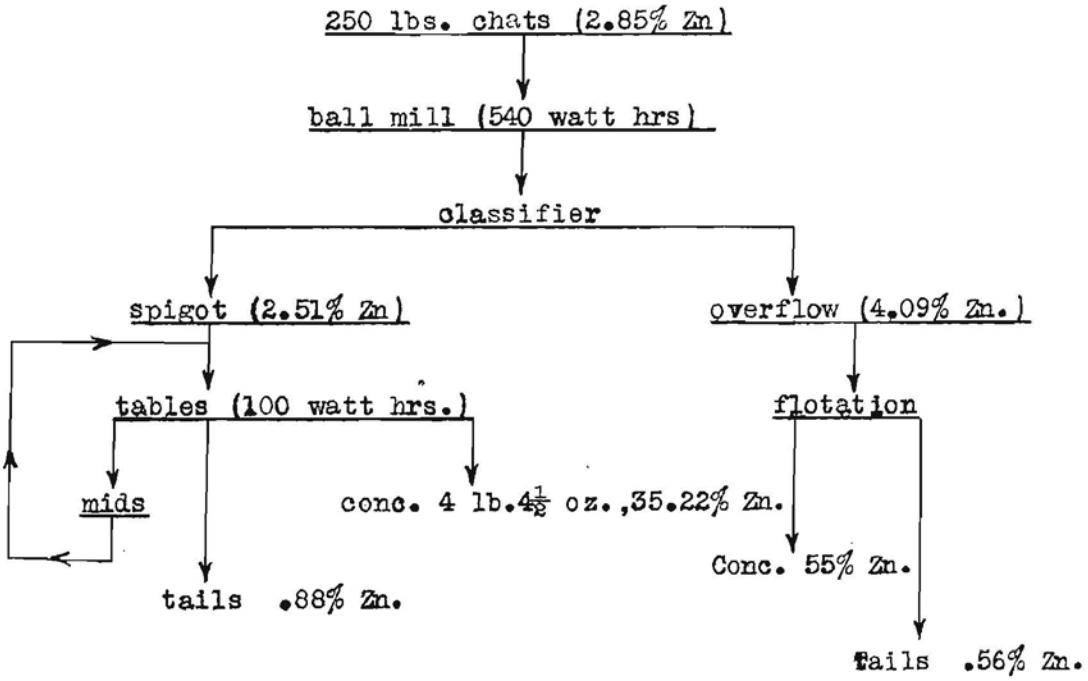
The third run was a duplication of the preceding one, except that 250 lbs. of chats was treated. A flow sheet of this operation, with results, is found on page 12. From these results, a table concentration of 69% was realized, and with a flotation

concentration of 93% a total concentration of 82% was obtained, or a total recovery of 46.74 lbs. of zinc per ton of chats treated. Using previous figures, a cost for power of .219 cents per pound of zinc recovered was calculated.

Flow Sheet Experiment No. Two.



Flow Sheet Experiment No. Three.



Experiment Four

On the last run 200 lbs. of the tailings from the rougher jigs and 100 lbs. of the tailings from the table were used. A mixture of this ratio gives a true sample of the chats from the tailings piles. An assay of this material showed it to contain 3.62% zinc.

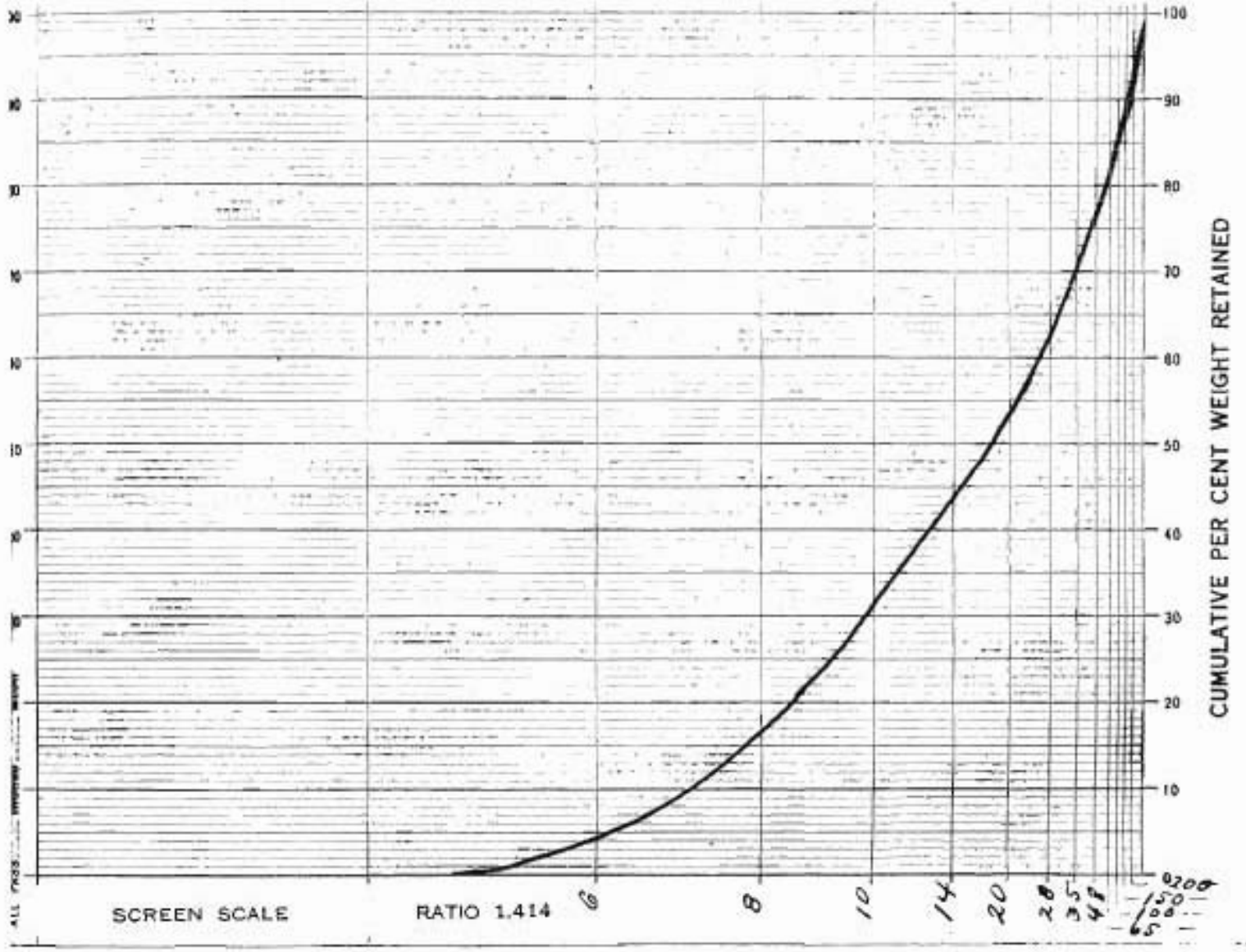
The chats from the rougher jigs were passed through the rolls and then mixed with those from the tables. The material was then ground in the ball mill and classified. The spigot and the overflow products were treated as previously stated. A screen analysis and a flow sheet with results for this experiment will be found on pages 14 and 15 respectively.

From these results a table extraction of 67% is obtained, and with a flotation extraction of 94% a total extraction of 83% results. Therefore, a recovery of 60.09 lbs. of zinc for each ton of chats treated is obtained. The cost for power in this operation amounted to .199 cents per pound of zinc recovered.

The Tyler Standard Screen Scale

Cumulative Direct Diagram of Screen Analysis on Sample of Run No 4 from rolls

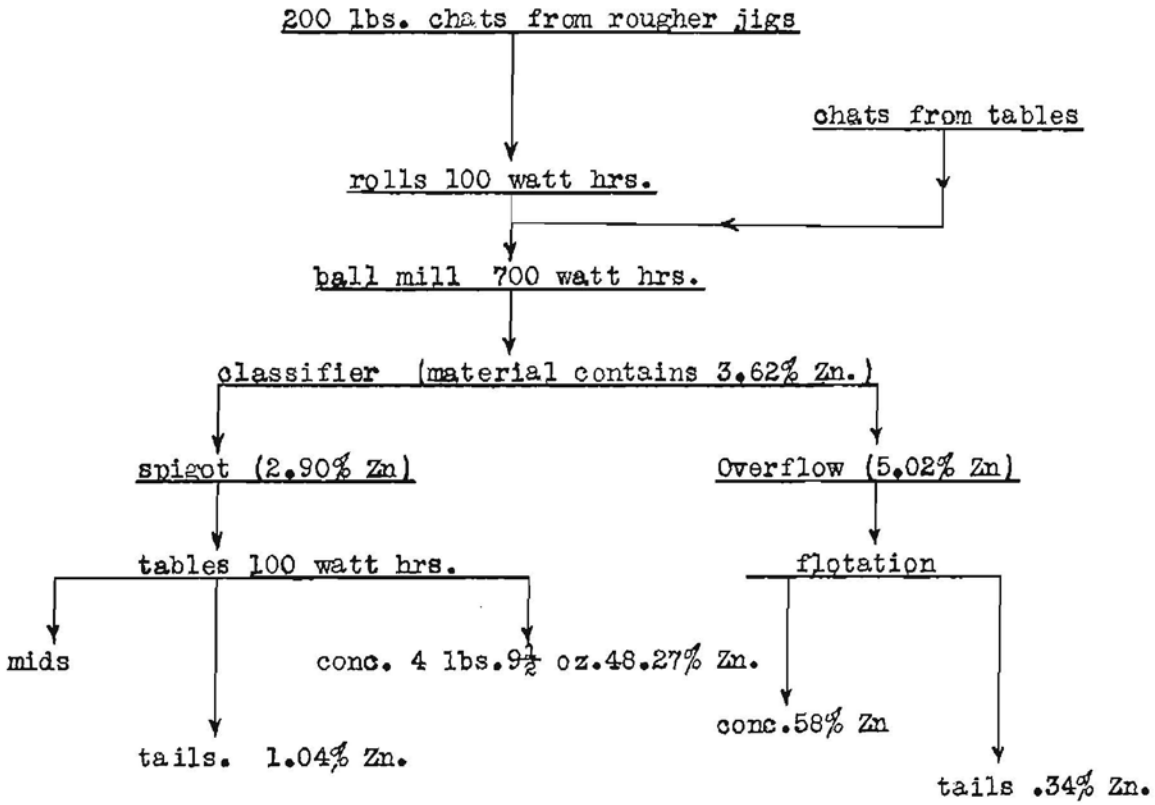
Name _____ Date _____



Sample Weights	Per Cent	Per Cent Cumulative Weights	% Zn	Screen Scale Ratio 1.414 — Openings: Inches	Openings: Millimeters	Mesh	Diameter Wire Inches
Gms.				1.050	26.67		.149
				.742	18.86		.135
300 gm sample				.526	13.33		.105
				.371	9.423		.092
				.263	6.680	3	.070
				.185	4.699	4	.065
14.3	4.7	4.7	1.24	.131	3.327	6	.036
31.7	10.5	15.2	1.72	.093	2.362	8	.032
48.1	16.0	31.2	2.12	.065	1.651	10	.035
40.1	13.3	44.5	2.33	.046	1.168	14	.025
29.7	9.9	54.4	2.17	.0328	.833	20	.0172
30.8	10.2	64.6	2.09	.0232	.589	28	.0135
21.6	7.2	71.8	2.07	.0164	.417	35	.0122
17.4	5.8	77.6	2.69	.0116	.295	48	.0092
14.4	4.8	82.4	3.68	.0082	.208	65	.0072
13.6	4.5	86.9	4.82	.0058	.147	100	.0042
12.0	4.0	90.9	10.15	.0041	.104	150	.0028
6.0	2.0	92.9	12.59	.0029	.074	200	.0021
20.1	6.7	99.6	14.16	.0029	.074	200	.0021
299.8	99.6						Totals.

THE W. S. TYLER COMPANY, CLEVELAND, OHIO

Flow Sheet Experiment No. Four



Machine: Minerals Separation

Experimenter: Delalaye + Kerr

ORE: Slime from classifier. Assays 4.09% Zn

EXPERIMENT STATION

Missouri School of Mines and Metallurgy

FLOTATION LABORATORY.

10% $CuSO_4$ Solution Used

OPERATING DATA

725 gm Ore	Dilution 4:1	R.P.M. Machi 1700

Test No	OIL No.	OIL Amt.	OIL Kind	REAGENTS Kind	REAGENTS Amt.	FROTH Kind	FROTH Amt.	REMARKS.	RESULTS Wt. gm	Per Ct. Zn	Wt. gm	Per Ct Zn	Wt. gm	Per Ct Zn	Per Ct. Ext.
		Drops			cc										
1		5	A. T.	$CuSO_4$	25	Good		Time — 15 Min.	45	57.3	6	9.7	674	0.47	89
2		7	"	"	40	"		" — 15 "	41	59.2	8	18.3	676	0.56	87
3		11	"	"	40	"		" — 16 "	43	58.7	17	9.6	665	0.36	96
4		6	"	"	16	"		" — 14 "	44	54.8	6	14.8	675	0.68	84
5		8	"	"	30	"		" — 15 "	53	52.3	7	10.5	665	0.27	96
6		8	"	"	50	"		" — 16 "	51	53.9	11	7.3	663	0.31	95

Flotation Sheet-Form-131-1000-8-19-H.

Machine Minerals Separation

Experimenter Delaloye & Kerr

ORE Slime from classifier Assays 4.09% Zn

EXPERIMENT STATION

Missouri School of Mines and Metallurgy

FLOTATION LABORATORY.

10% $CuSO_4$ Solution Used

OPERATING DATA

725 gm Ore	Dilution 4:1	R.P.M. 1700

Test No	OIL No.	OIL Amt.	OIL Kind	REAGENTS Kind	REAGENTS Amt.	FROTH Kind	FROTH Amt.	REMARKS.	RESULTS Wt. gm	RESULTS Per Ct. Zn	RESULTS Wt. gm	RESULTS Per Ct Zn	RESULTS Wt. gm	RESULTS Per Ct Zn	Per Ct. Ext.
		Drops			cc										
7		20	A.T.	$CuSO_4$	60	Good		Time – 20 Min	47	56.8	12	12.7	666	0.34	95
8		10	"		35	"		" – 20 "	53	53.0	5	8.4	667	0.33	95
9		12	"		15	"		" – 16 "	55	50.6	8	9.2	662	0.26	96
10		9	"		20	"		" – 20 "	54	51.9	25	4.1	646	0.10	98
11		6	"		25	"		" – 12 "	52	55.0	7	7.1	666	0.14	97
12		7	"		30	"		" – 15 "	48	55.3	7	13.0	670	0.42	92

Flotation Sheet-Form-181-1000-8-19-H.

Machine. Minerals Separation

Experimenter. Delaloye + Kerr

EXPERIMENT STATION

Missouri School of Mines and Metallurgy

FLOTATION LABORATORY.

ORE: Slime from classifier. Assays 4.09% Zn

10% Solution $CuSO_4$ Used

OPERATING DATA

725 gm Ore	Dilution 4:1	R.P.M 1700

Test No	OIL No.	OIL Amt.	OIL Kind	REAGENTS Kind	REAGENTS Amt.	FROTH Kind	FROTH Amt.	REMARKS.	RESULTS Wt. gm	Per Ct. Zn	Wt. gm	Per Ct Zn	Wt. gm	Per Ct Zn	Per Ct. Ext.
		Drops			cc										
13		7	A.T.	$CuSO_4$	40	Good		Time — 15 Min.	47	55.8	9	10.2	669	0.34	95
14		7	"		50	"		" — 14 "	48	53.1	17	6.9	660	0.43	90
15		9	"		60	"		" — 15 "	50	52.9	12	8.6	663	0.40	91

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Flotation Sheet-Form-181-1000-8-19-H.

Machine. Minerals Separation

Experimenter. Delaloye + Kerr

EXPERIMENT STATION

Missouri School of Mines and Metallurgy

FLOTATION LABORATORY.

OPERATING DATA

ORE: Slime from classifier. Assays 5.02% Zn.

10% $CuSO_4$ Solution Used

725 gm Ore	Dilution 4:1	R.P.M. 1700

Test No.	OIL No.	OIL Amt.	OIL Kind	REAGENTS Kind	REAGENTS Amt.	FROTH Kind	FROTH Amt.	REMARKS.	RESULTS Wt. gm	Per Ct. Zn	Wt. gm	Per Ct Zn	Wt. gm	Per Ct Zn	Per Ct. Ext.
		Drops			cc										
16		7	A.T.	$CuSO_4$	30	Good		Time – 15 Min	52	53.5	14	22.9	659	0.54	88
17		6	"	"	20	"		" – 15 "	50	57.1	19	24.7	656	0.09	97
18		6	"	"	10	"		" – 15 "	48	58.7	23	36.1	654	0.14	97
19		7	"	"	10	"		" – 15 "	38	60.0	17	39.3	670	0.68	87
20		6	"	"	10	"		" – 15 "	52	59.7	12	32.9	661	0.07	98
21		6	"	"	10	"		" – 15 "	44	58.4	12	39.6	669	0.54	90

Conclusions

In drawing conclusions, the last experiment will have to be referred to, as it represents the treatment of a true sample of the chats that are discarded in the district. The results obtained from the tables are not as good as those obtained from flotation; but, referring to the work described on page one, the critical crushing point of this material is through 65-mesh. An average of these experiments shows that about 40% of the material classified is spigot product and must be tabled; the remaining 60% must be floated. The results of the experiments on the flotation of these chats are to be found on pages 16 to 19 inclusive.

From these results one can see that a good extraction can be obtained by flotation. Experimental work on the flotation of these chats showed that the best oil to use was the A. T. mixture, manufactured by the Newport Chemical Company, Passaic, N. J. The only other reagent that was used was copper sulfate, the amount of which was varied in the different charges. This amount was varied from 6 cc to 60 cc of a 10% solution, and it was found that the best results were obtained when 10 cc were used. This would amount to 1 pound of copper sulfate per ton of chats treated. The amount of oil was also varied, but it was found that 6 drops per charge of 700 gms. was sufficient, or 6 lbs. per ton.