1916

The flotation of a West Joplin, Mo. slime

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THE FLOTATION OF A WEST JOPLIN, MO. SLIME.

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BY

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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

Degree of

BACHELOR OF SCIENCE IN MINE ENGINEERING

and

BACHELOR OF SCIENCE IN MINE ENGINEERING.

Rolla, Mo.

1916.

Approved by. Horace J. Mann

Acting Professor of Metallurgy and Ore Dressing.

Thesis. Flotation of a west Joplin Slime.
Hoffmann and Dowd. 1916.

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THE FLOTATION OF A WEST JOPLIN, MO. SLIME.

Introduction.

Owing to the high price of zinc and the success attending flotation in other districts, intense interest was aroused in the flotation of slimes of the South-West Missouri District. These slimes are the accumulation of the finer particles of the ore during the milling process and their metallic content is generally higher than that of the original ore. They have been disposed of, in the past, by sluicing them to the tailings ponds because no economical method of saving the zinc had been discovered.

The object of our experiments was to economically extract from these slimes, by flotation, a product of sufficient zinc content to be of commercial value. To carry on this experiment in a practical manner, a dried slime was obtained from a West Joplin pond. This material came to us in two lots and will be referred to in further statements, as "Ore No. 1" and "Ore No. 2".

All experimental work was performed in the flotation laboratory of the Missouri School of Mines and Metallurgy.

Preliminary Tests.

In order to determine the nature of the ore, such characteristics as its alkalinity, chemical analysis, physical analysis, and screen analysis were determined. The results are tabulated below:

Physical analyses of ores (microscopic):-

Chert and calcitic gangue,

Sulfides of zinc, lead, and iron,

No included material.

Chemical analyses of ores:

	%Zn.	%Pb.	% Fe.
Ore No. 1	5.92	5.45	1.48
Ore No. 2	5.40	2.60	.98

Alkalinity of Ore and tap water:

Water requires .519 lb. of H_2SO_4 per ton to neutralize.

Ores require approximately 200 lb. of H_2SO_4 per ton to neutralize. (Large amount due to calcitic part of gangue being dissolved by the acid.

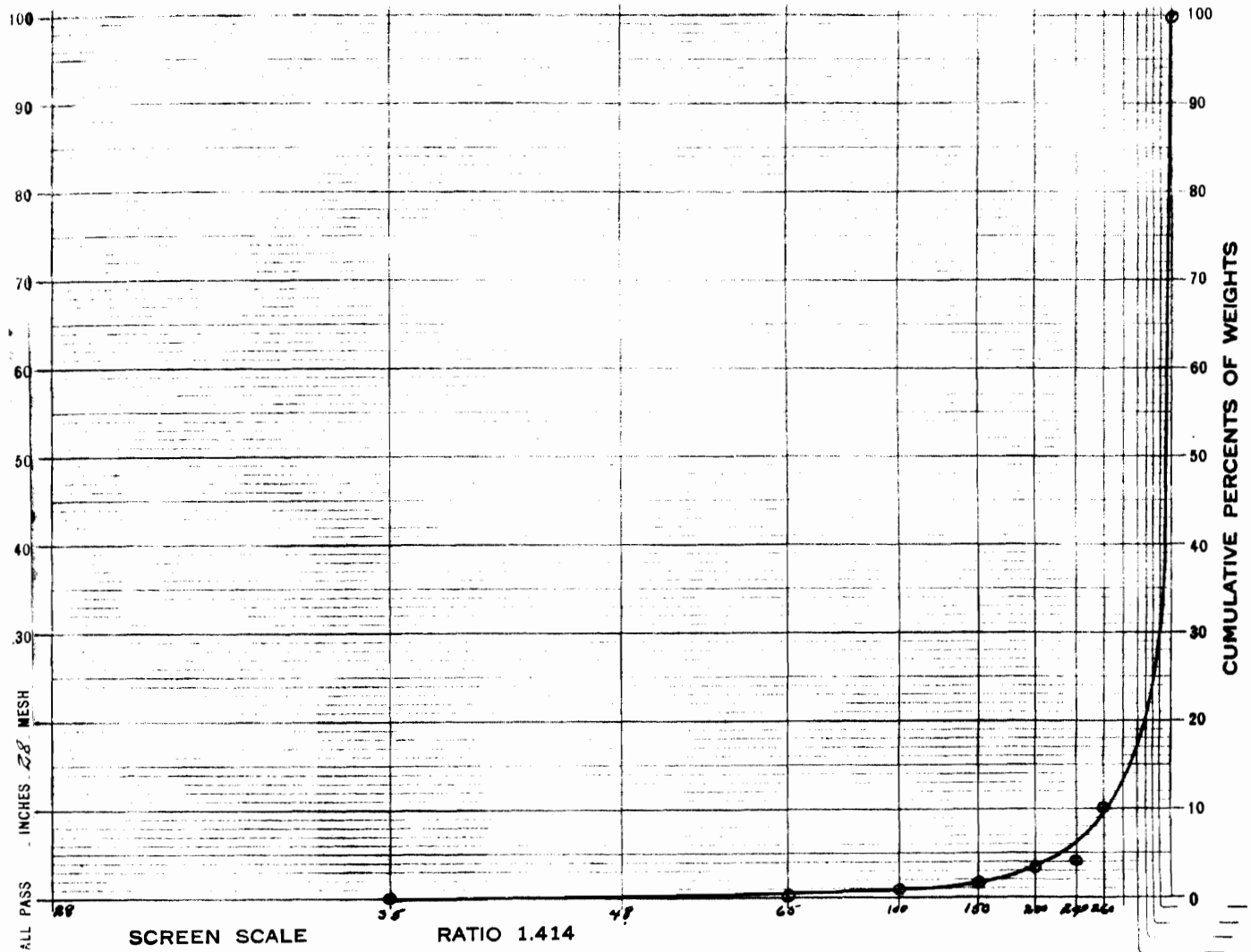
Screen Analysis on 500 gm. of ore: (See p.3)

This analysis did not include any of Ore No. 2 but it was supposed that it was similar to the first ore.

The Tyler Standard Screen Scale

Cumulative Direct Diagram of Screen Analysis on Sample of West Joplin Slime

Name Hoffman & Dowd **Date** Feb. 4, 1916.



ndicate the Screen Crushed through and also First Retaining Screen	SCREEN SCALE RATIO 1.414 Openings Inches	Openings Milli-meters	Mesh	Diameter Wire Inches	WEIGHTS Sample Weights	Per Cent	Per Cent Cumulative Weights	ASSAYS Zinc	ASSAYS Lead	CONTENTS	% of Total Conte
	1.050	26.67		.149							
	.742	18.85		.135							
	.525	13.33		.105							
	.371	9.423		.092							
	.263	6.680	3	.070							
	.185	4.699	4	.065						500 gm. Sample	
	.131	3.327	6	.086							
	.093	2.362	8	.082							
	.065	1.651	10	.085							
	.046	1.168	14	.025							
	.0328	.833	20	.0172							
Thru	.0232	.589	28	.0125							
On	.0164	.417	35	.0122			.360	1.0	1.64		
	.0116	.295	48	.0092			.730	2.62	0.00		
	.0082	.208	65	.0072			1.090	4.77	1.42		
	.0058	.147	100	.0042			1.980	3.40	1.81		
	.0041	.104	150	.0026			3.710	1.61	.92		
	.0029	.074	200	.0021			4.865	1.10	1.53		
	.0029	.074	270	.0021			10.466	2.02	1.42		
			400				100.000	5.83	2.73		
				Totals.							

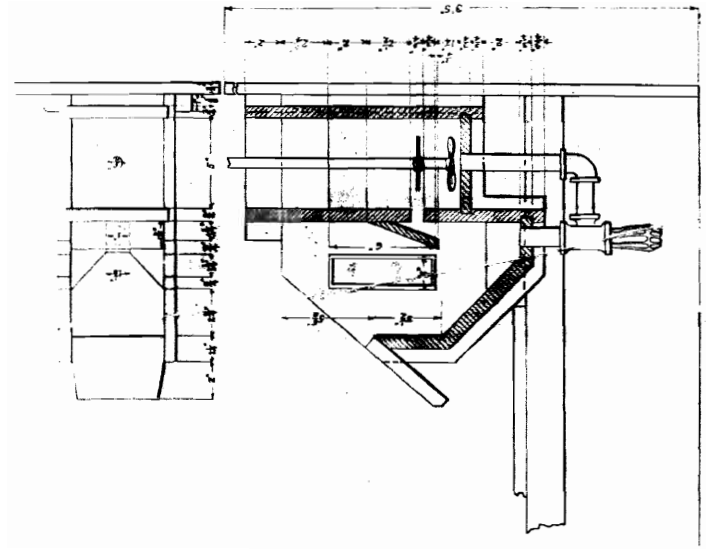
*Note: material on 65 mesh was prin. ciually wood pulp.

Before the work was commenced in the experimental machines, test tube flotation with various oils was tried. The manner in which this was carried on was as follows:-

Into an ordinary 8-inch test tube was placed a charge of 30 cc. water, 10 gm. of ore and one drop of the oil to be tested. After shaking the tube for a few minutes, the amount and character of the froth was noted and the surface of the charge was skimmed. The skimmings were placed on watch glasses to dry and from a microscopic examination of these products, the oils were classified as (1) frothing, (2) selective, (3) non-frothing, (4) non-selective or combinations of these terms, as applied to that particular oil used. This test was applied to some 60 oils, after which various combinations of two and three oils were tried. Among the oils tested in this manner, were vegetable oils, mineral oils, acids, and so-called flotation oils.

TESTS WITH MINERALS SEPARATION MACHINE.

A sketch of this machine showing dimensions etc. is shown on the following page. The impellers of the



agitator were 4 inches in diameter. The shaft, being run at a speed of 1750 r.p.m. gave the impellers a peripheral speed of 1820 feet per minute. The power to drive the agitator was taken from a one-eighth H.P. Westinghouse D.C. belt-driven motor.

At first, the tests were made using 800 grams of ore and 4000 cc. of tap water (a dilution of 1 to 5). These charges were agitated in the machine for a few minutes, before the oils were added, in order to thoroughly mix the pulp. Then an oil, which we had found to be a selector in our test tube experiments, was added (usually not more than three drops) and the agitation continued for 5 or 10 minutes longer. The selector was added first so that the sulfide particles would be wetted and thus to enable the frothing oil to raise them to the surface. The frothing agent used (oil or soap) was one which gave a moderately stiff froth and medium size bubbles, the largest of which were about 3/4 inch in diameter. It was found that larger bubbles invariably carried an excessive amount of gangue and a stiff froth carried as much gangue as concentrate.

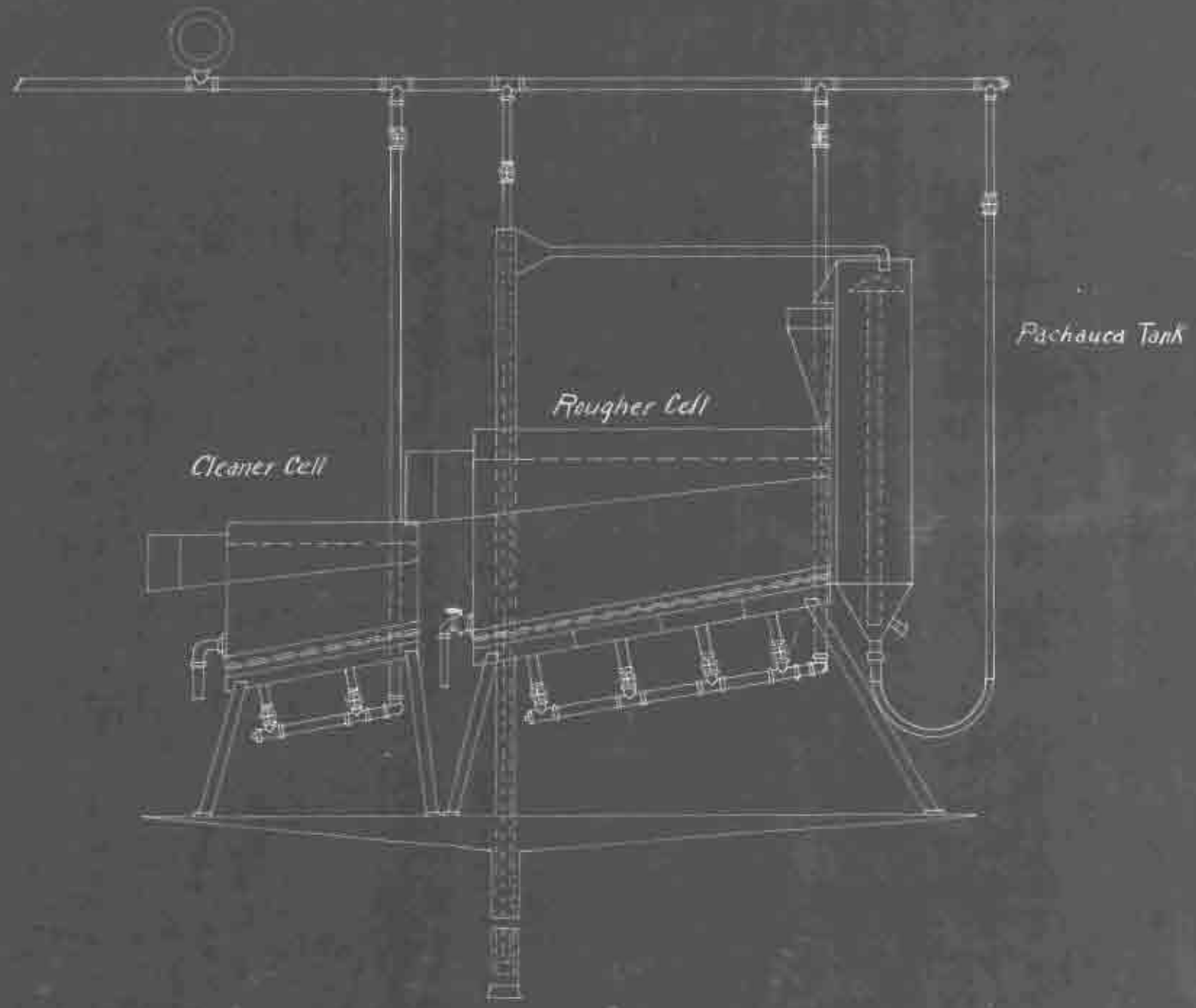
The froth which was formed on the surface of the

solution in the spitzkasten was allowed to accumulate without overflow, for about 10 minutes, after which it was carefully skimmed off by means of a perforated skimmer. Further skimmings were made when the froth collected in sufficient quantities to warrant such. More oil was added whenever it was found necessary; this being determined by the amount of sulfide brot to the surface upon addition of a small amount of oil. As this machine had only one cell, it became necessary to distinguish between what was termed concentrate and middling, by means of the color of the froth; varying from straw yellow to dark gray.

When the froth apparently carried no sulfides, the machine was discharged and the tailings were saved. The concentrates, middlings and tailings were slowly dried to prevent roasting of the sulfides, on a hot plate, weighed and microscopically examined, to determine whether they were of sufficient grade to warrant their chemical analysis. If so, they were analyzed for zinc, lead, and iron. The methods used in these determinations were the ferrocyanide for the zinc; the ammonium molybdate for the lead; and the potassium permanganate for the iron.

TESTS WITH THE CALLOW PNEUMATIC MACHINE.

Similar tests, as those just mentioned, were carried out with an experimental size Callow Flotation machine (shown on following page). With this machine the best results were obtained using from 1000 to 2000 gm. of ore. A preliminary mixing in a Minerals Separation machine hastened a separation in the Callow unit.


Pachauca Tank
Rougher Cell
Cleaner Cell

OILS USED IN THE FOLLOWING TESTS:

Lab. No.	Name of oil	Supplied by.
6	No. 8 Flotation oil	Gen. Naval Stores Co.
7	No. 17 " "	" " " "
10T	Turpentine	Pensacola T &T Co.
12	Cushing's Crude	Water's Pierce Co.
15	Pine Oil #6	Gen. Naval Stores Co.
17	No. 200 Flotation	Pensacola T & T Co.
18	Florida 400	" " "
21	No.75 Crude Wood	" " "
23	" 350 " "	" " "
33	Water Gas Tar	Laclede Gas Co. Station A St. Louis.
45	Rosin Oil	Einer Amend
51	Coal Tar	Public Service Co., Chicago, Ill.
53	No.2 Flotation	Barrett Mnfg. Co.
56	Chrysilic Acid	
61	No. 17 Flotation	Gen. Naval Stores Co.
350	#350 Crude Wood	Pensacola Co.
1580	#1580 Flotation	" "

Results of Tests:

Ex. 1.

Charged 800 grams of ore and 4000 grams of water into a Minerals Separation machine and agitated for a few minutes. Added 11 drops of no. 6 and 12 drops of 1CT from a medicine dropper and took concentrates and tailings. Examined under a microscope. Too much froth.

Concentrates poor	Wt. 90 grams
Tailings	" 701 ".

Ex. 2.

Same charge of ore and water in machine with 6 drops of No. 6 and 7 drops of No. 10. Poor concentrate. Fair froth, but substantial.

Concentrates poor	Wt. 59.6 grams
Tailings	720. grams

Ex. 3.

Same charge of ore and water in machine with 6 drops of No. 6 and 9 drops of No. 33. Concentrates no good. Froth not substantial enough.

Concentrates poor	Wt. 26.0 grams

Ex.4.

Charged 800 grams of ore and 4000 grams of water into a Minerals Separation machine and agitated for a few minutes. Added 8 drops of No. 15 and 8 drops of No. 61.

Concentrates poor	Wt. 45.0 gram
Tailings	565 gram

Ex.5.

Charged 800 grams of ore and 4000 grams of water into a Minerals Separation machine and agitated for a few minutes. Added 8 drops on No. 350 and 7 drops of No. 10 T. Fair froth.

Concentrates poor	Wt. 63 grams
Tailings	726 grams.

Ex. 6.

Same charge in same machine with 4 drops of No. 7 and 8 drops of No. 61. Froth appeared dirty, so 3 drops of No. 53 were added. No improvement.

Concentrates poor	Wt. 37 grams
Tailings	658 grams.

Ex. 7.

Charged 800 grams of ore and 4000 grams of water into a Minerals Separation machine and agitated for a few minutes. Added 10 drops of No. 6 and 5 drops of No. 54 from a medicine dropper. Good froth.

Concentrates poor	Wt. 37. grams
Tailings	726 grams

Ex. 8.

Used 600 grams of ore and 4000 grams of water in the same machine. Oils used were 4 drops of No. 6 and 8 drops of No. 18. Froth good.

Concentrates poor	Wt. 48. grams
Tailings	439 grams

Ex. 9.

Used 480 grams of ore with 4000 grams of water in machine. Used 8 drops of No. 6 and 4 drops of No. 45. Made concentrat, middling and tailings which were examined under the microscope.

Concentrates poor	Wt. 33 grams
Tailings	294 grams
Middlings fair	42 grams

Ex.10.

Charged 800 grams of ore and 4000 grams of water in a Minerals Separation machine together with 14 drops of No. 21 and 7 drops of No. 45. Fair froth.

Concentrates fair	Wt.	56. grams
Middlings fair		42 grams
Tailings		446 grams.

Ex. 11.

With usual charge of 800 grams of ore and 4000 grams of water, 10 drops of a mixture of 1 part of No. 23 with 19 parts of No. 56 (by volume) were added. Fair froth.

Concentrates fair	Wt.	56.0 grams
Tailings		628 grams.

Ex. 12.

Same charge using 14 drops of No. 7. After the concentrate was taken off, the charge was re-Oiled with 9 drops of No. 7. Too much oil was used.

Concentrates poor	wt.	20 grams
Middlings poor		17 grams
Tailings		680 grams

Ex. 13.

Usual charge with 14 drops of No. 17 and 7 drops of No. 1580. Froth weak.

Concentrates no good	Wt. 29 grams
Tailings	642 grams

Ex. 14.

Charged Minerals Separation machine with 800 grams of ore and 4000 grams of water. Charge was acidified with H_2SO_4 equivalent to 1 lb. per ton. Acid seemed to kill froth. Machine choked up, so no tails or concentrates were saved.

Ex. 15.

Charged Minerals Separation machine with 800 grams of ore and 2000 cc. water. Agitated with 15 drops of No. 21 and 15 drops of No. 45. Added 2000 cc. more of water after first agitation. Also added acid equivalent to 1 lb. per ton. Acid seemed to bring gangue to surface and no advantage was gained by adding half of water at a time.

Concentrates no good	Wt. 22 grams
Middlings no good	18 grams
Tailings	640 grams

Ex.16.

Used 800 grams charge of ore and 4000 grams of water. Added 15 drops of No. 21 and 10 drops of No. 45. Ten cc. of NH_4OH added after 5 minutes agitation. Reagent seemed to improve color of froth.

Concentrates no good	Wt. 21 grams
Middlings no good	22 grams
Tailings	722 grams

Ex. 17.

Usual charge with 14 drops of No. 17 and 7 drops of 1580. Charge acidified with H_2SO_4 equivalent to 1 lb. per ton. Too much froth which caused overflow. No results recorded.

Ex. 18.

Usual charge with 10 drops of No. 12 and 10 drops of no. 17 (drops from a medicine dropper). Good froth. Bubbles were large and thick but gradually thinned out.

Concentrates no good	Wt. 54 grams
Middlings no good	18 grams
Tailings	630 grams

Ex. 19.

Charged 800 grams of ore and 4000 grams of water into Minerals Separation machine. Used 12 drops of No. 17, 6 drops of 1580 and 2.5 cc. of concentrated NH_4OH.

Concentrates		Wt. 19 grams.
Zinc	45.8%	
Pb.	4.2%	
Middlings		Wt. 60 grams.
Zn.	32.5%	
Pb.	---	
Tailings		Wt. 651 grams
Zn.	1.2%	

Zinc Recovery 60.1%

Ex. 19 a.

Regular charge to machine with 20 drops of No. 21, 10 drops of No. 45 and 1 lb. acid per ton of pulp. Acid was added after concentrate was taken off. A large dirty concentrate was made which was retreated without addition of oil.

Concentrates		Wt. 66 grams.
Zn.	42.06%	
Pb.	7.09%	
Middlings		Wt. 8 grams.
Zn.	17.06%	

Tailings Wt. 685 gm.

Zn. .7%

Zinc Recovery 82 %

Ex. 20.

Same charge using 12 drops (from medicine dropper) of 51 and 6 drops of No. 7. Used 10 cc. of Old Country Soap made from 5 gm. soap in 500 cc. water. Good froth. Concentrates made with No. 51 and soap. Middlings made with No. 7.

Concentrates Wt. A 10 grams

B 13 grams

A Zn. 46.4%
Pb. 12.1%

B Zn. 34.0%
Pb. 2.3%

Middlings Wt. 116 grams

Zn. 8.5%

Tailings Wt. 613 grams

Zn. 1.4%

Zinc Recovery 40.5%

Ex. 21.

Same charge as in No. 20, using 8 drops of 51 and 5 cc. of soap solution. Middlings made with 4 drops of No. 7 Good froth.

Ex. 21-Continued.

Concentrates		Wt. 35 grams
Zn.	56.0%	
Pb.	6.6%	
Middlings		Wt. 30 grams
Zn	39.0%	
Tailings		Wt. 648 grams
Zn	1.92%	

Zinc Recovery 66.5%

Ex. 22.

Agitated regular charge with 6 drops of No. 21 and 2 drops of 45. Added 4 drops of 21 and 3 more drops of 45 and then drew concentrate A. Added 4 more of 21 and 2 more drops of 45 and drew concentrate B. Added 4 more drops of 21 and 7 more of 45 and drew concentrate C.

Concentrates			A Wt. 18 grams B Wt. 23 grams C. Wt. 7 grams.
A	Zn.	47%	
	Pb.	3.2%	
B.	Zn.	39.5%	
	Pb.	3.8%	
C.	Zn.	30.1%	
	Pb.	14.5%	

Ex. 22 Continued.

Tailings Wt. 699 grams

Zn. 2.9%

Zinc Recovery 41.8%

Regular charge of 800 grams of ore and 4000 grams of water agitated with 12 drops of No. 51 for one half hour before adding 2 cc. of soap solution. Good froth. Charge re-oiled with 3 drops of No. 7 after concentrate was removed.

Concentrates A. Wt. 15 grams
B. Wt. 10 grams

A. Zn. 54.2%
Pb. 7.5%

B. Zn. 38.6%
Pb. 7.4%

Middlings Wt. 31.5 gram

Zn 40.0%

Tailings Wt. 702 grams

Zn 2.6%

Zinc Recovery 52.4%

Ex.24.

The regular charge was used in the Minerals Separation machine with 8 drops of No. 51 and 5 cc. of Grandpa's Tar Soap solution (made up in the same manner as the Old Country). No froth obtained and hence no concentrate was taken.

Ex. 25.

A charge of 2000 grams of ore with 8000 grams of water was agitated in a larger machine using a residium oil. 25 drops were used and a large dirty concentrate was made which was retreated with no results. No record was taken.

Ex. 26.

Charged machine with 800 grams of ore again using 14 drops of No. 21 and 10 drops of No. 45 oils.

Concentrates Wt. 30.5 grams

Zn. 45.2%

Tailings not saved.

Zinc recovery 28.8%

Ex. 27,28,29.

Charges were agitated with varying amounts of the residium oil. Amounts used were 5 drops, 10 drops and 20 drops. None of these charges gave a separation.

Ex. 30.

Charged Minerals Separation machine with 400 grams of ore and 4000 grams of water. Oils used were 1 drop of No. 51 and 2 drops of 15 with 5 cc. of Old Country soap solution. The soap was added 1 cc. at a time. This charge with the two following ones gave dirty concentrates which were retreated on a Callow.

Ex. 31.

Charge same as Ex. 30 using 2 drops of 51, 1 drop of 15, and 2 drops of No. 21.

Ex. 32.

Charge same as Ex. 30, using 3 drops of 51, 2 drops of No. 15 and 2 drops of No. 10 T. The turpentine was added to emulsify No. 51. This charge gave the best results of the three. The total concentrates was combined as charge 33, and totaled about 600 grams.

Ex. 33.

See three previous charges for this charge. No additional oil was added, when above concentrates were placed in the Callow machine. Froth too stiff.

Concentrates — A. Wt. 42 grams. B. Wt. 20 grams.

	A.	B.
Zn.	53.5%	50.3%
Pb.	11.5%	4.2%

Middlings — Wt. 60 grams.

Zn. 44.%

Tailings — Wt. 352 grams.

Zn. 1.02%

Zinc Recovery 82.9%

Ex. 34.

Regular charge agitated with 20 drops of No. 21. Good froth. Tailings lost.

Concentrates — Wt. 25.5 gm.

Zn. 47.5%

Zinc Recovery 25.7%

Our intention was to table the products made in these experiments, in order to separate the lead and thereby increase the value of the concentrates. However, time did not permit and this was not done.

Conclusions.

From the foregoing tests, we concludes that a combination of a selector and frother was preferable to a single oil, and that approximately .6 lb. oils should be used per ton of ore. The ratio of dry ore to water which gave the best results was one to four. Soda with a selector, gave good results.

As to the choice of a machine, we are not fully prepared to draw any conclusions, except in a general way. With what few tests we made on the Callow machine, using pine oil, it seemed to give more satisfactory results than the Minerals Separation machine. A continuous series of treatments would increase the percentage of extraction, as from 3 to 5% of concentrates is lost by adherence to the machine. This amount of zinc was washed into our tailings.