1917

Selective concentration of a complex ore by flotation

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SELECTIVE CONCENTRATION OF A COMPLEX ORE BY FLOTATION

BY

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and

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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

Rolla, Mo.

1917.

Approved by . Horace F. Mann .

Associate Professor of Metallurgy and Ore Dressing

Table of Contents.

SELECTIVE CONCENTRATION OF A COMPLEX ORE BY FLOTATION.

Introduction:

The problem of the Mining Engineer and Metallurgical Engineer who wishes to treat the slimes and fine sands of a complex ore is the recovery and separation of minerals so as to render a subsequent treatment of any mineral profitable. The minerals must be separated into groups which can be treated by different processes, because a combination of numerous minerals is extremely undesirable at the smelting plant. In a lead ore the presence of zinc often depletes its value to such an extent that it is umprofitable to treat it; likewise with other minerals and ores. Many systems of selective separation of slimes and fine sands have been tried but with little success. The latest attempt towards this end has been by means of the flotation process. The eagerness to separate the minerals of a complex sulphide ore is seen in a retrospection of the great number of patents that have been issued. These patents bring into consideration, a vast number of chemical solutions which are used as selectors in the flotation process.

The object of our experiment work was to find the best method of selective flotation adaptable to a particular ore at hand.

The Hoover type of Minerals separation machine was used to run the tests.

Each charge was as follows:

Ore.	800 gm.
Water.	4000 "
Dilution of pulp.	5 to 1
Oil.	.5#/Ton
Time of run.	20 minutes.
Speed of impeller.	2000 R.P.M.

All factors of operation remained constant except the reagents.

Preliminary Tests.

A physical and chemical test was made of the ore and the results obtained are:

Alkalinity of the ore and tap water:

The tap water required .488 pounds of sulphuric acid per ton to neutralize it.

The ore required approximately 2.8 pounds of sulphuric acid per ton to neutralize it.

Chemical Analysis of the ore:

Pb.	3.25%
Zn.	29.02%
Fe.	8.90%
As.	0.80%

Traces of... As, Sb, Au, Ag,.

Physical Analysis of the ore;

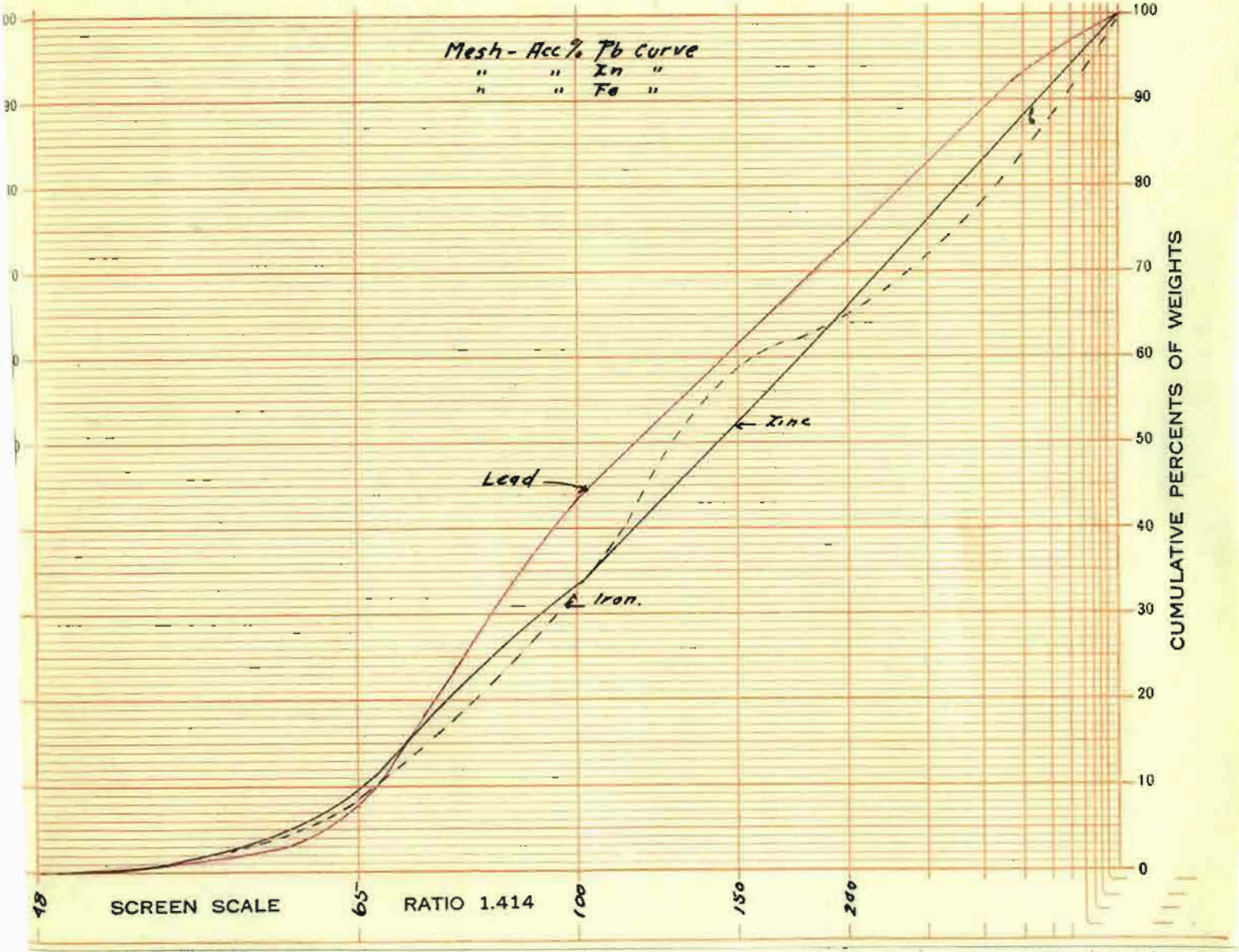
Small portions of the products from the screen analysis were examined with the microscope to determine which mesh the greatest number of grains were broken free.

Mesh	65	100	150	200	250
No. of grains examined	10000	10000	10000		
" " middling grains	864	13	4		
% " " "	8.64%	1.3%	.4%		

The Tyler Standard Screen Scale

Cumulative Direct Diagram of Screen Analysis on Sample of *Copeland Ore.*

Name *Pope and Dale* Date *May 3, 1917.*

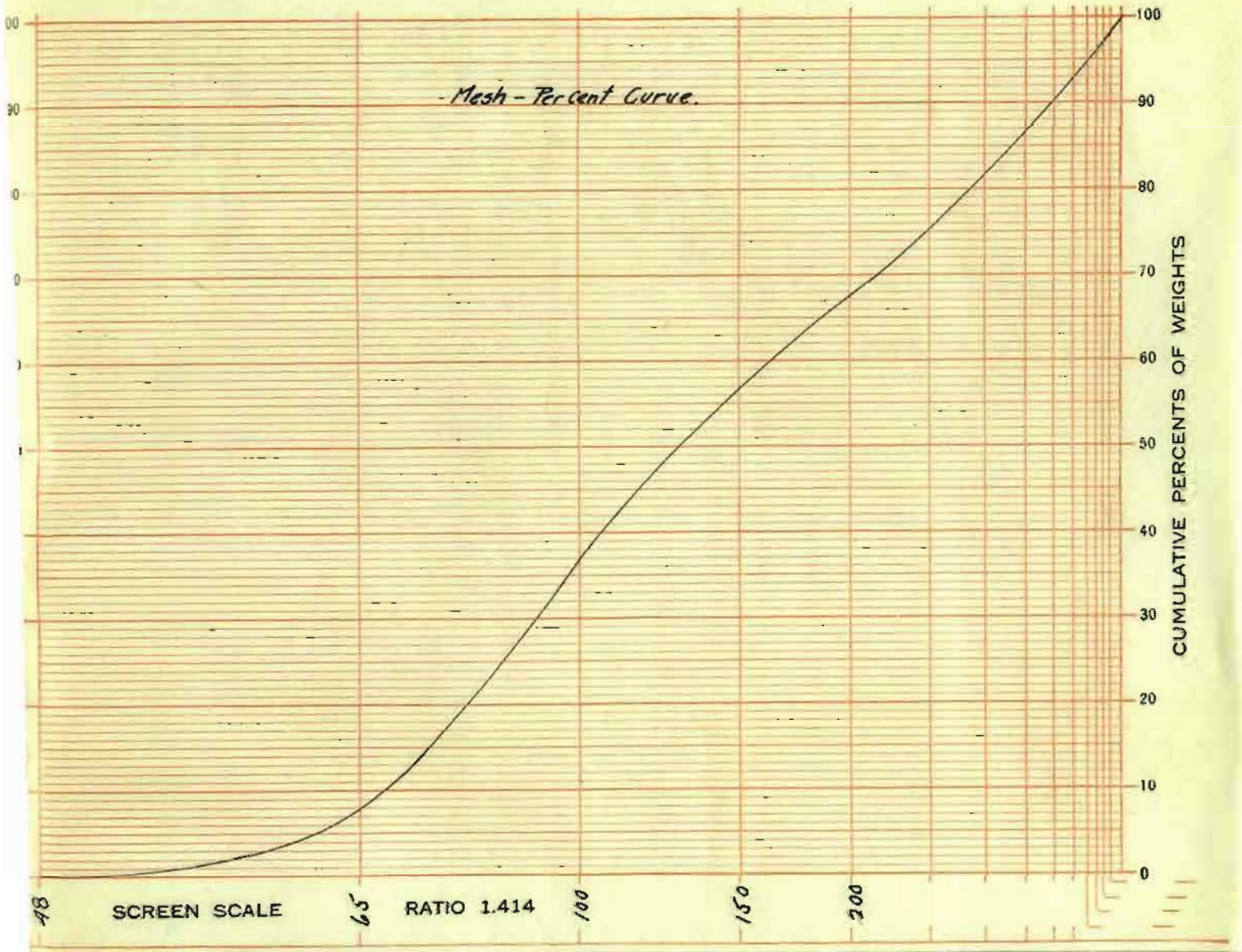


the Screen d through lso First aining reen	SCREEN SCALE RATIO 1.414				WEIGHTS			ASSAYS			CONTENTS			% of Total Content		
	Openings		Mesh	Diameter Wire Inches	Sample Weights	Per Cent	Per Cent Cumulative Weights									
	Inches	Milli-meters														
	1.050	26.67		.149												
	.742	18.85		.135												
	.525	13.33		.105												
	.371	9.423		.092												
	.263	6.680	3	.070												
	.185	4.699	4	.065												
	.131	3.327	6	.036												
	.093	2.362	8	.032												
	.065	1.651	10	.035												
	.046	1.168	14	.025												
	.0328	.833	20	.0172												
	.0232	.589	28	.0125												
	.0164	.417	35	.0122												
48	.0116	.295	48	.0092												
65	.0082	.208	65	.0072												
100	.0058	.147	100	.0042												
150	.0041	.104	150	.0026												
200	.0029	.074	200	.0021												
	.0029	.074	200	.0021												
				Totals.												

The Tyler Standard Screen Scale

Cumulative Direct Diagram of Screen Analysis on Sample of *Copeland Ore*

Name *Pope and Dale* Date *May. 3. 1917.*



the Screen d through lso First aining reen	SCREEN SCALE RATIO 1.414				WEIGHTS			ASSAYS			CONTENTS			% of Total Content		
	Openings		Mesh	Diameter Wire Inches	Sample Weights	Per Cent	Per Cent Cumulative Weights	%Pb	%Zn	%Fe	Accumulative %Pb	Accumulative %Zn	Accumulative %Fe	%Pb	%Zn	%Fe
	Inches	Millimeters														
	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												
	.131	3.327	6	.036												
	.093	2.362	8	.032												
	.065	1.651	10	.035												
	.046	1.168	14	.025												
	.0328	.833	20	.0172												
	.0232	.589	28	.0125												
	.0164	.417	35	.0122												
48	.0116	.295	48	.0092												
65	.0082	.208	65	.0072	38.90	7.78	7.78	3.21	34.80	10.00	7.7	9.30	8.20	7.70	9.30	8.2
00	.0058	.147	100	.0042	145.70	29.80	36.96	3.28	34.10	7.60	43.2	33.50	32.30	35.50	33.60	29.6
50	.0041	.104	150	.0026	100.40	20.80	57.00	3.00	27.90	11.40	61.6	52.70	59.10	18.40	19.20	25.8
00	.0029	.074	200	.0021	61.84	10.10	67.40	3.67	39.90	9.30	73.3	66.00	64.90	11.70	13.30	10.8
00	.0029	.074	200	.0021	163.20	32.60	100.00	2.68	30.20	8.28	100.0	100.00	100.00	26.70	34.00	36.2
				Totals,												

Machine Hoover Type

Experimenter Tapx + Dale

Missouri School of Mines and Metallurgy

FLOTATION LABORATORY.

OPERATING DATA.

Time 20 Min

ORE "Thesis"

Test No	OIL No.	OIL Amt.	OIL Kind.	REAGENTS Kind	REAGENTS Amt.	FROTH ~~Kind~~ ~~Amt.~~	REMARKS.	RESULTS Concentrates Wt.	Concentrates Per Ct.		Tailing Wt.	Tailing Per Ct.		Extraction Per Ct. Ext.		
					c.c	Weight of Conc.			% Pb	% Zn	% Fe	% Pb	% Zn	% Fe	% Pb	% Zn	% Fe
2			Flot #17 + Flot #22			192			2.84	25.9	12.6	2.81	29.9	7.88	20.9	21.4	34.0
3			Flot #17	H_2SO_4	5	77			4.73	28.3	8.73	3.12	29.12	8.90	13.9	9.38	9.4
4			" "	$MnSO_4$	50	168			3.11	23.8	8.10	3.29	30.40	9.10	20.1	17.20	19.1
5			Flot #200			118			3.71	26.64	8.10	3.17	29.38	9.03	16.8	13.5	13.4
6			" "	SO_3	50	48			3.44	39.61	13.67	3.23	28.22	8.59	6.3	8.18	9.2
7			Flot #8	BaOH	100												
			+ Creosote #1	+ H_2SO_4	5	39			3.24	47.2	7.80	3.25	28.1	8.94	4.86	7.9	4.27
8			Cresylic #54	"	"	80			2.26	38.66	8.55	3.36	27.93	8.90	6.90	13.3	9.6
9			" "			86			4.79	34.50	8.82	3.05	28.38	8.91	15.8	12.8	10.6
10			Oleic Acid	NaCl	50gr												
				H_2SO_4	5	57			1.68	44.6	18.2	3.30	28.20	8.18	3.7	10.9	14.5
11			No 8 Flot			184			3.71	35.98	10.66	3.11	27.02	8.38	26.3	28.5	27.5

Machine Hoover Type

Experimenter Pope & Dale

ORE

Missouri School of Mines and Metallurgy

FLOTATION LABORATORY.

Concentration of a complex ore by means of selective flotation

(Thesis)

OPERATING DATA.

Time 20 Min

Test No	OIL No.	OIL Amt.	OIL Kind.	REAGENTS Kind	REAGENTS Amt.	FROTH ~~Kind~~	FROTH ~~Amt.~~	REMARKS.	RESULTS ~~Wt.~~	~~Per Ct.~~	~~Wt.~~	~~Per Ct.~~	~~Wt.~~	~~Per Ct.~~	~~Per Ct. Ext.~~
					cc	Weight of Conc.			Concentrates			Tailings			Extraction
									%Pb	%Zn	%Fe	%Pb	%Zn	%Fe	%Pb	%Zn	%Fe
12			Flot #22 + Oil #152	H_2SO_4	5	38			4.72	21.21	7.61	3.18	29.4	8.90	6.9	3.5	4.0
13			Pugh #20			115			3.98	34.52	10.58	3.48	26.64	8.60	8.5	17.1	12.2
14			Flot #17	$KMnO_4$	50	33			4.21	39.9	10.61	3.21	28.55	8.82	5.3	5.65	4.9
15			Flot #8	NH_4OH	100	101			4.12	41.2	9.40	3.11	27.7	8.83	16.0	17.7	13.3
16			Flot #105			86			4.16	38.63	13.71	3.14	27.88	8.31	13.7	14.3	16.5
17			Cresylic #54	KOH	50	73			4.03	46.8	15.44	3.17	27.2	8.24	11.3	14.7	16.8
18			Oleic Acid	NaOH	50												
				H_2SO_4	5	38			3.51	31.62	26.13	3.22	28.6	8.02	5.1	4.8	13.9
19			Cresylic #54	K_2SO_4	50	85			3.71	28.92	10.46	3.2	29.0	8.71	12.1	10.6	12.5
20			Flot #8	Al Alum	25	125			3.98	37.16	11.52	3.1	27.5	8.42	19.1	19.9	20.2
21			Flot #18														
			Flot #400	K_4FeCN_6	25	110			5.37	35.48	13.23	2.9	27.8	8.21	22.8	16.7	20.4

Machine Hoover Type

Experimenter Paget Dale

Missouri School of Mines and Metallurgy

FLOTATION LABORATORY.

OPERATING DATA.

Time 20 Min

ORE "Thesis"

Test No	OIL No.	OIL Amt.	OIL Kind.	REAGENTS Kind	REAGENTS Amt.	FROTH ~~Kind~~	FROTH ~~Amt.~~	REMARKS.	RESULTS ~~Wt.~~	~~Per Ct.~~	~~Wt.~~	~~Per Ct.~~	Wt.	Per Ct.	Per Ct. Ext.	
					cc	Weight of conc			Concentrates				Tailings			Extraction
									%Pb	%Zn	%Fe	%Pb	%Zn	%Fe	%Pb	%Zn %Fe
22			Eucalyptus #53			55			3.99	16.27	14.33	3.19	29.22	8.48	83	62 11.0
23			Flot 17#	$MnSO_4$	30			ore roasted 1 hr								
			Creosote #56			24		at 200° to 300°C	5.01	23.2	9.38	3.19	29.2	8.88	4.62	2.4 3.16
24			Flot #17					ore heated 100° to								
			Oleic Acid			38		150°C ½ hr (Wentworth)	4.67	16.1	35.3	3.18	29.69	7.58	6.8	2.0 18.8
25			Flot #6	NH_4OH	50	61			5.11	18.8	7.82	3.09	29.8	8.98	11.9	4.9 6.7
26			Flot #4	$CuSO_4$	25	79			4.07	34.2	7.00	3.20	28.4	9.11	12.3	11.6 7.7
27			Flot #1 & 133	$BaOH$	20	89			3.81	19.6	10.3	3.20	30.1	8.57	13.0	7.5 12.8
28			Flot #17	$CdSO_4$	50	6			4.67	28.9	11.46	3.20	28.9	8.9	1.16	.8 .9
29			" "	"	30											
			turpentine #1			6			3.20	46.28	4.50	3.25	28.0	8.7	.7	1.0 .38
30			Flot #17	$CuSO_4$	100	17			4.44	25.1	5.25	3.23	29.1	8.8	2.9	1.8 1.2

Machine Hoover Type

Experimenter Tape & Dale

ORE

Missouri School of Mines and Metallurgy

FLOTATION LABORATORY.

"Thesis"

OPERATING DATA.

Time 20 Min

Test No	OIL No.	OIL Amt.	OIL Kind.	REAGENTS Kind	REAGENTS Amt.	FROTH ~~Kind~~	FROTH ~~Amt.~~	REMARKS.	RESULTS ~~Wt.~~	~~Per Ct.~~	~~Wt.~~	~~Per Ct.~~	Wt.	Per Ct.	Per Ct. Ext.	
					cc	Weight of Conc.			Concentrates			Tailings			Extraction	
									%Pb	%Zn	%Fe	%Pb	%Zn	%Fe	%Pb	%Zn	%Fe
31			Flot #4	$Ba(OH)_2$	100	74			5.20	28.92	8.37	3.06	28.3	8.9	14.7	9.2	8.7
32			" "	$MnSO_4$	"	95			5.98	20.16	8.73	2.8	30.2	8.8	21.8	8.6	11.6
33			" "	$K_4Fe(CN)_6$	"	33			4.78	33.51	7.70	3.2	28.7	9.0	6.1	4.7	3.5
34			Pine Oil #6	KNO_3	"			(Delprat)									
				HNO_3	10	104			1.87	24.16	12.4	3.4	29.7	8.4	7.5	10.8	18.6
35			Flot #75	"	"			"									
				KNO_3	150	325			2.13	24.22	10.85	4.0	32.4	7.3	26.6	33.8	19.6
36			" "	K Alum	50	70			4.51	28.65	6.12	3.13	29.3	9.2	12.1	8.6	6.0
37			Flot #4	$KMnO_4$	100	135		Rolled 1 hr (Owen)	2.28	32.89	12.61	3.4	28.2	8.04	11.8	19.2	23.9
38			Flot #4														
			Flot #17	$KMnO_4$	150	165		(Owen)	4.23	13.30	19.80	3.02	33.2	6.22	26.9	9.4	45.8
39			Creosote #19			60			1.01	13.70	9.60	3.30	30.2	8.7	2.3	3.5	8.1

Machine Hoover Type

Experimenter Pope & Dale

Missouri School of Mines and Metallurgy

FLOTATION LABORATORY.

OPERATING DATA.

Time 20 Min.

ORE "Thesis"

Test No	OIL No.	OIL Amt.	OIL Kind.	REAGENTS Kind	REAGENTS Amt.	FROTH ~~Kind~~	FROTH ~~Amt.~~	REMARKS.	RESULTS Concentrates ~~Wt.~~	~~Per Ct.~~ Pb	~~Per Ct.~~ Zn	~~Per Ct.~~ Fe	Tailings ~~Wt.~~	~~Per Ct.~~ Pb	~~Per Ct.~~ Zn	~~Per Ct.~~ Fe	Extraction ~~Per Ct.~~ Pb	~~Per Ct.~~ Zn	~~Per Ct.~~ Fe Ext.
					cc	Weight of Conc				% Pb	% Zn	% Fe		% Pb	% Zn	% Fe	% Pb	% Zn	% Fe
55			Flot #75	KCN	60cc	1% sol		Nothing doing	—	—	—	—	—	—	—	—	—	—	—
56			Flot #17	$KMnO_4$	5			Poor Separation	—	—	—	—	—	—	—	—	—	—	—

Flotation Sheet-Form-131-1000-1-18-H.

Machine Hoover Type

Experimenter Pope + Dale

Missouri School of Mines and Metallurgy

FLOTATION LABORATORY.

OPERATING DATA.

Time 20 Min

ORE "Thesis"

Test No	OIL No.	OIL Amt.	OIL Kind.	REAGENTS Kind	REAGENTS Amt.	FROTH Kind	FROTH Amt.	REMARKS.	RESULTS								
										Wt.	Per Ct.	Wt.	Per Ct.	Wt.	Per Ct.	Per Ct. Ext.	
					cc	Weight of conc				Concentrates			Tailings			Extraction	
										% Pb	% Zn	% Fe	% Pb	% Zn	% Fe	% Pb	% Zn	% Fe
47			Flot #4	$NiNO_3$	100	89		(Lyster)	3.36	31.92	9.11	3.2	28.6	8.4	11.6	12.2	11.2
48			Flot #1580	K_2CrO_4	100	63		(Greenway and Lowry)	2.98	33.06	10.55	3.32	28.6	8.8	7.3	8.9	8.9
49			Cresylic Acid	$MnSO_4$	100			ore roasted 300°-400°									
			turpentine	NaOH	50	236		3hrs (Horwood)	1.85	15.2	7.11	3.8	22.3	9.8	16.8	45.8	23.5
50			Cresylic Acid			406		Cl_2 water used (Odlings)	1.22	20.0	1382	5.3	36.3	3.7	19.0	35.0	78.7
51			Flot #17			387		" " " "	.97	26.4	14.8	5.3	31.2	3.1	14.4	44.0	80.5
52			Flot #400					ore roasted 300°-400°									
			Flot #8			87		3hrs (Horwood)	.60	47.8	4.11	3.5	26.6	9.3	2.0	17.9	5.0
53			Flot #8			101		ore roasted 300°-400°	1.11	52.1	3.68	3.5	25.7	4.4	4.3	22.6	5.2
								3hrs (Horwood)									
54			Flot #75	$KClO_3$	50	—		Much froth Nothing picked up									

Flotation Sheet-Form-181-1000-1-16-H.

Machine Hoover Type

Experimenter Pape + Dale

ORE

Missouri School of Mines and Metallurgy

FLOTATION LABORATORY.

"Thesis"

OPERATING DATA.

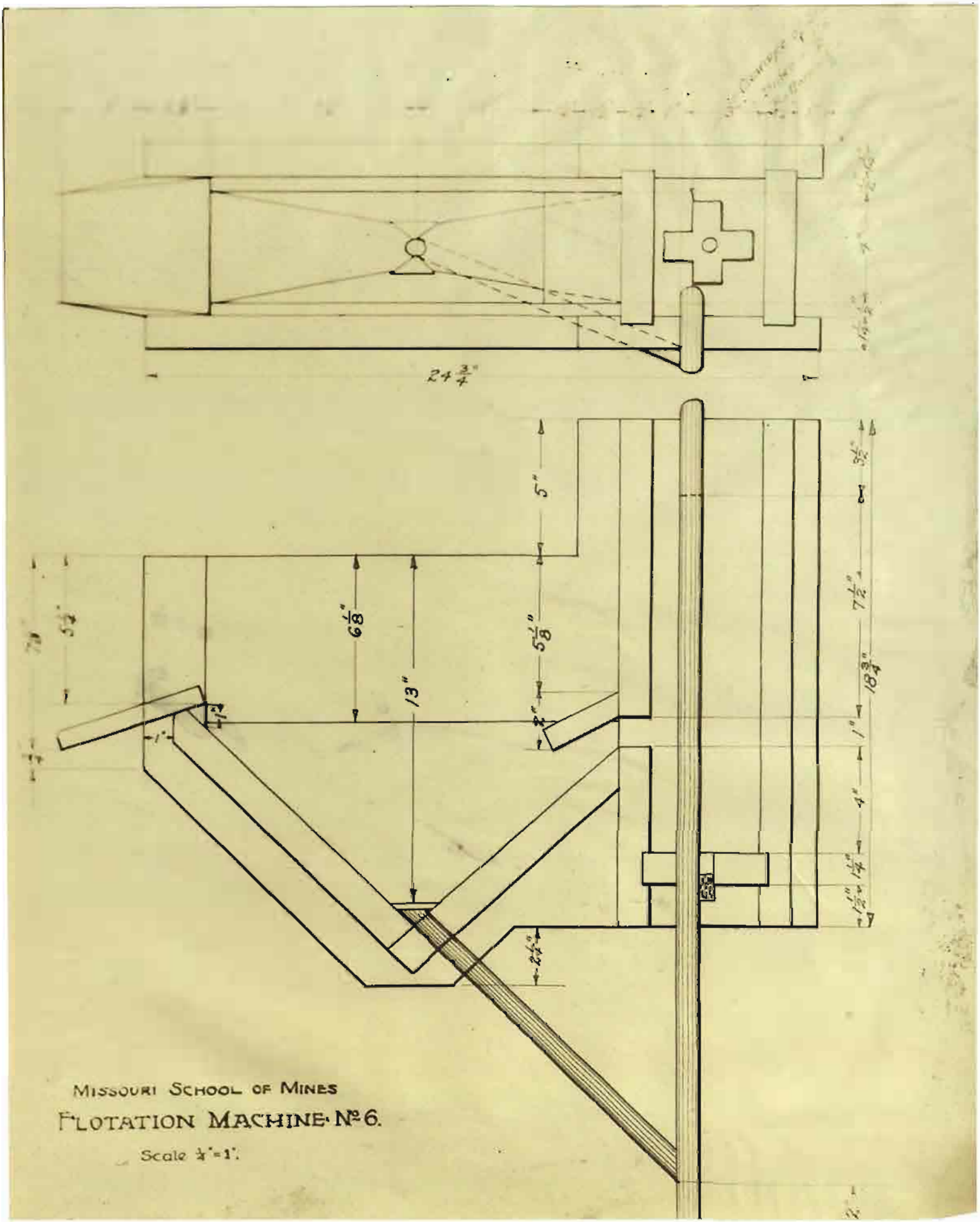
Time 20 Min

Test No	OIL No.	OIL Amt.	OIL Kind.	REAGENTS Kind	REAGENTS Amt.	FROTH Kind	FROTH Amt.	REMARKS.	RESULTS Concentrates Wt.	Concentrates Per Ct.		Tailings Wt.	Tailings Per Ct.		Extraction Per Ct.		
					cc	Weight of conc.											
									% Pb	% Zn	% Fe	% Pb	% Zn	% Fe	% Pb	% Zn	% Fe
40			Flot #4														
			Flot #17	Nitre Cake	60	112			3.36	26.82	8.88	3.23	34.3	10.4	10.8	13.03	14.2
41			Creosote #19	K_2SO_4	50	126			2.33	23.20	8.70	3.42	29.3	8.93	11.2	14.5	15.3
42			" "	$CoNO_3$	"	91		(Lyster)	3.78	16.40	10.5	3.40	30.7	8.30	13.2	6.4	13.4
43			Cresylic Acid	NaOH	50												
			turpentine	$MnSO_4$	100	38			4.60	18.50	10.3	3.18	29.5	8.70	6.7	3.0	5.5
44			same as (43)														
			plus Flot #18			65			4.12	29.85	10.94	3.1	28.5	8.4	10.2	8.4	10.07
45			Cresylic	$MnSO_4$	100												
				H_2SO_4	20	153			5.01	33.2	18.6	2.83	28.2	6.62	29.5	20.9	40.0
46			Eucalyptus #53			212		SO_2 gas used (Bradford)	4.82	5.37	21.6	2.7	37.7	4.09	39.4	4.8	64.3

Conclusion.

From the results obtained, the selective action of the different reagents may be seen. The best results of selective separation were secured by the Horwood Process. This was followed by results of diminishing value obtained from the Bradford, Delprat and Wentworth processes.

Many of the results show a tendency toward selective separation, but they are not distinctive enough to be used on a commercial scale. These results were obtained by running the tests twenty minutes. Probably, if these tests were run forty minutes or an hour, there might have been an appreciable distinction of separation one over the other, to warrant their use for this particular ore.



MISSOURI SCHOOL OF MINES

FLOTATION MACHINE. No 6.

Scale ½"=1'.

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