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Flotation tests on a table sludge from the Golden Rod Milling Company at Tar River, Oklahoma

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FLOTATION TESTS ON A TABLE SLUDGE FROM THE
GOLDEN ROD MILLING COMPANY AT
TAR RIVER, OKLAHOMA.

BY

William H. Kamp.

A

T H E S I S

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
ENGINEER OF MINES IN MINE ENGINEERING

Rolla, Mo.

1921

Approved by

Charles Clayton

Professor of Metallurgy and Ore Dressing.

FOREWORD

The author is indebted to Mr. M. H. Thornberry, Research Metallurgist of the Missouri State Experiment Station, for suggestions and encouragement during the progress of the work.

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INTRODUCTION

The purpose of this experimental work is to give to the operators of the Joplin District some facts concerning the possibilities of flotation in their district. An attempt will be made to show that high-grade concentrates can be made economically; also that the concentrate so made will be a distinct addition to that made by usual gravity concentration. It is believed that the oil and reagent used will not put a prohibitive cost burden upon the operators. It is, of course, realized that flotation concentrates of any zinc tenor bear a penalty because of the fineness of the product.

The sludge for these tests was obtained from the Golden Rod Mining and Smelting Corporation, Tar River, Oklahoma. The material was barreled wet and when received contained approximately 25 per cent moisture.

A portion of the sludge was taken, thoroughly mixed, and sampled. A chemical analysis of the sample gave the following results:

Zn - - - - -	13.77
Fe - - - - -	0.92
CaO - - - - -	6.83
Pb - - - - -	0.76
Insoluble- - -	55.51

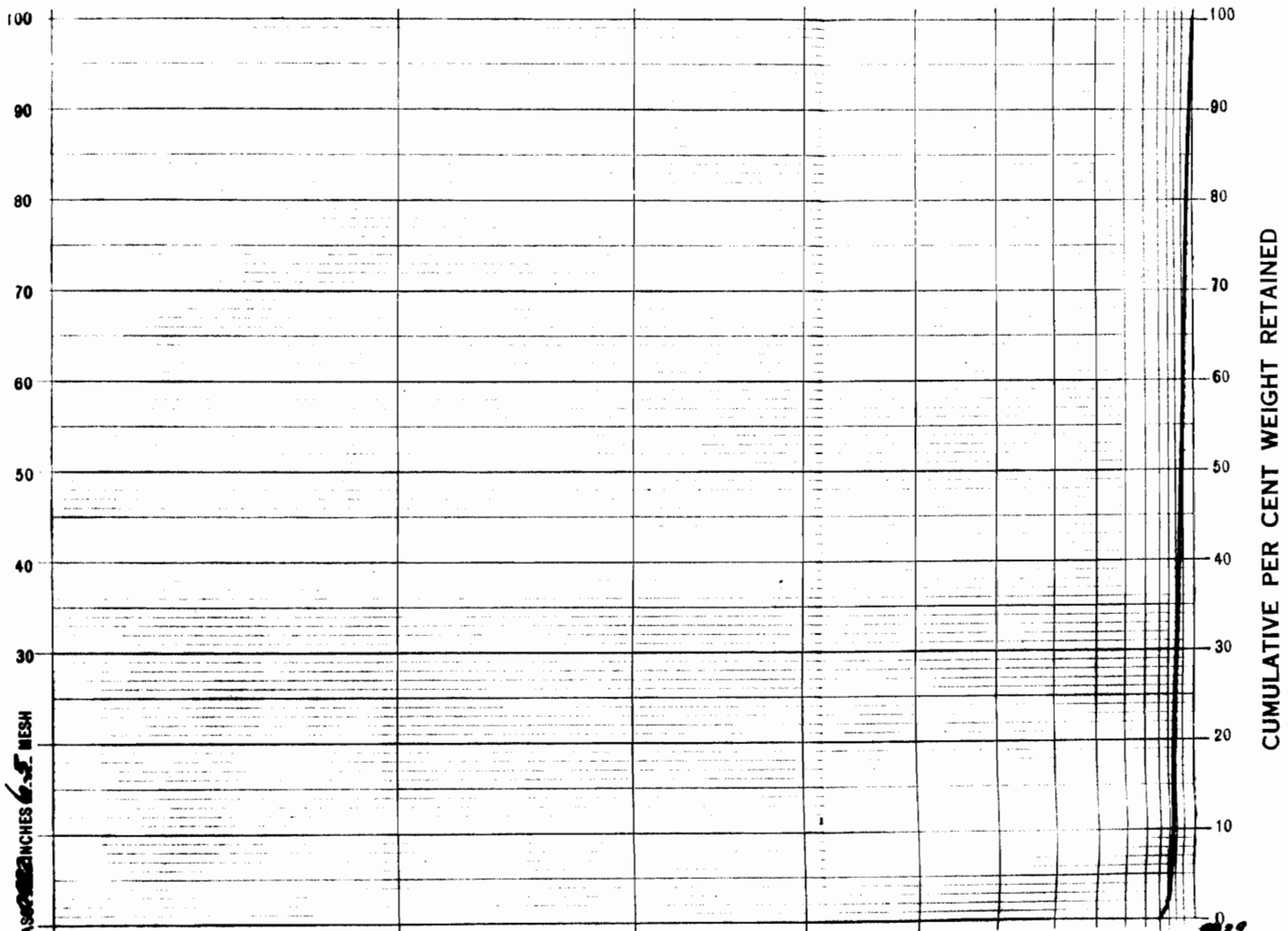
A screen analysis of the sludge was next made. The result of this analysis is shown on a separate sheet. It was found necessary to make this analysis on the wet material because when dried the screen openings were clogged, due to the fineness of the sludge.

The Tyler Standard Screen Scale

Cumulative Direct Diagram of Screen Analysis on Sample of Golden Rod Sludge

Name W. H. Kamp

Date _____



SCREEN SCALE

RATIO 1.414

0.029
0.042
0.058
0.074

Indicate the Screen Crushed through and also First Retaining Screen

SCREEN SCALE RATIO 1.414

Indicate the Screen Crushed through and also First Retaining Screen	Openings		Mesh	Diameter Wire Inches	Sample Weights	Per Cent	Per Cent Cumulative Weights	%	% Total Zn on each screen
	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					
	.0116	.295	48	.0092					
	.0082	.208	65	.0072					
	.0058	.147	100	.0042	9.28	2.25	2.25		0.13
	.0041	.104	150	.0026	73.70	17.83	20.08		5.20
	.0029	.074	200	.0021	124.50	30.13	50.21		20.61
	.0029	.074	200	.0021	205.70	49.79	100.00		23.79

All Pass Retained in

Totals

PRELIMINARY TESTS

A series of preliminary tests were next made for the purpose of ascertaining the oil or combination of oils and reagents best suited to float the blende in this sludge. In making these tests the weight of ore was approximated, placed in laboratory Janney flotation machine, and different oils and reagents added and the effect noted. The results of these preliminary tests are tabulated on pages 9 and 10 of this thesis.

In the preliminary tests the A. T. and X. Y. mixture from the Newport Chemical Company, Passiac, New Jersey, when used with copper sulphate produced such remarkable results that it was decided to confine the research work to the use of these oils and copper sulphate. The data on these final tests are recorded on special sheets, which are self explanatory.

CONDITION OF EXPERIMENTS

The tests were all made in a laboratory flotation machine of the Mineral Separation type. The method of conducting the experiments was as follows: A portion of the sludge was thoroughly mixed and the moisture determined. A charge of wet pulp containing approximately 700 grams of dry ore was weighed and poured into the machine with sufficient tap water to give the charge a dilution of five parts of water to one of dry ore, by weight. The machine was started and allowed to run until the charge was well mixed, after which a quantity of oil equivalent to 0.5 pound per ton of dry ore was added and the agitation continued. Copper sulphate was then added and the froth skimmed off. The froth when removed was divided into two portions and designated as concentrate and middling. The concentrate was that portion which was skimmed off as long as the froth appeared to be laden with blende. The middling was removed after the concentrate and until apparently no more blende was carried up with the bubbles. The duration of each test was 15 to 20 minutes and the speed of the machine was 1700 r. p. m. The data on these tests are recorded on pages 11, 12 and 13 of this thesis.

Several charges were run to determine the minimum amount of copper sulphate necessary to float the blende in this sludge. It was found that this reagent produced the best results when added all at one time and after the oil had been added. The

results show that 70 cc of a one per cent solution of copper sulphate produced a very good concentrate and a good extraction. Seventy cubic centimeters of the copper sulphate solution means approximately two pounds of the reagent per ton of sludge treated.

CONCLUSIONS:

1. Copper sulphate is the main factor in the concentration of the blende in this sludge by flotation.

2. Either the A. T. mixture or the X. Y. mixture, or a combination of the two, in conjunction with copper sulphate, were the oils best suited to float the blende in this sludge.

3. From 50 cc to 70 cc of a one per cent solution of copper sulphate produced the best results.

4. Small amounts of copper sulphate added at intervals did not raise the blende as well as when added all at one time.

5. Another interesting factor is that the oil must be added first. When the copper sulphate was added to the charge before it was poured into the machine, practically no blende floated.

Machine *Janney*

Experimenter *W.H. Kamp*

ORE *Table Sludge from Golden Rod Mining and Smelting Co. P. Tar River, Okla. Zn = 13.77%*

EXPERIMENT STATION

Missouri School of Mines and Metallurgy

FLOTATION LABORATORY.

OPERATING DATA

*Time = 15 to 20 minutes
Ore = 700 grams
Water = 3500 grams
Speed of Machine = 1700 RPM*

Test No	OIL			REAGENTS		FROTH		REMARKS.	RESULTS						
	No.	Amt. <small>Drops</small>	Kind	Kind	Amt. <small>cc</small>	Kind	Amt.		Wt.	Per Ct.	Wt.	Per Ct.	Wt.	Per Ct.	Per Ct. Ext.
1	19	5	<i>Crude Fine oil</i>												
	117	5	<i>Ref. Creosote</i>	<i>H₂SO₄</i>	10	<i>Wet</i>		<i>Fairly good conc.</i>	-	-	-	-	-	-	-
2	128	5	<i>5th Pine Oil</i>	-	-	<i>Wet</i>		<i>Dirty Conc.</i>	-	-	-	-	-	-	-
	117	5	<i>Ref. Creosote</i>	-	-	<i>Wet</i>		<i>Good Conc.</i>	-	-	-	-	-	-	-
3	127	5	<i>Creosote</i>	-	-	<i>Dry</i>		<i>First Dirty and then cleaner</i>	-	-	-	-	-	-	-
	130	5	<i>Flot. Oil.</i>	-	-	<i>Dry</i>		<i>Not enough froth to make it run over</i>	-	-	-	-	-	-	-
4	117	5	<i>Ref. Creosote</i>	-	-	<i>Wet</i>		<i>Better Conc.</i>	-	-	-	-	-	-	-
	A.T.	5	<i>Mixture Newport Chem.</i>	-	-	<i>Wet</i>		<i>No Froth</i>							
5	X.Y.	5	<i>"</i>	-	-	<i>Wet</i>		<i>More Froth than without A.T. but not enough</i>							
	A.T.	5	<i>"</i>	<i>CuSO₄</i>	<i>Any</i>	<i>Dry</i>		<i>Very good looking concentrate</i>							
6															

Machine *Mineral Separation*

Experimenter *W. H. Kamp*

ORE *Table Sludge from
Goldsboro Red Mining
and Smelting Corp.
Tar River, Okla.
Zn = 13.77%*

EXPERIMENT STATION

Missouri School of Mines and Metallurgy

FLOTATION LABORATORY.

OPERATING DATA

*Time = 15 to 20 minutes
Ore = 700 grams
Water = 3500 Grams
Speed of Mach. = 1700 R.P.M.*

Test No	OIL			REAGENTS		FROTH		REMARKS.	RESULTS						
	No.	Amt.	Kind	Kind	Amt.	Kind	Amt.		Wt.	Per Ct.	Wt.	Per Ct.	Wt.	Per Ct.	Per-Ct. Ext.
7	<i>H.T.</i>	<i>5</i>	<i>Newport Chem. Wks.</i>	<i>FeSO₄</i>	<i>Any</i>	<i>Poor</i>	-	<i>No affect on Sphalerite FeSO₄ must have had some affect on CuSO₄</i>							
8	<i>H.T.</i>	<i>5</i>	<i>"</i>	<i>MgSO₄</i>	<i>Any</i>	<i>"</i>		<i>No Conc.</i>							
9	<i>19</i>	<i>5</i>	<i>Crude Pine Oil</i>	<i>CuSO₄</i>	<i>Any</i>	<i>Wet</i>		<i>Good Conc. but gangue with it.</i>							
10	<i>117</i>	<i>5</i>	<i>Ref. Creosote</i>	<i>CuSO₄</i>	<i>"</i>	<i>"</i>		<i>Good Conc. and more clean</i>							
11	<i>H.T.</i>	<i>5</i>	<i>Newport Chem. Wks.</i>	<i>ZnSO₄</i>	<i>"</i>	<i>Poor</i>		<i>Poor Conc.</i>							
12	<i>H.T.</i>	<i>10</i>	<i>"</i>	<i>CuSO₄</i>	<i>60</i>			<i>CuSO₄ added to jar and agitated. Put into machine and oil added. No good. Then 25cc. CuSO₄ added and Zn came up immediately.</i>							<i>No analysis.</i>
13	<i>X.Y.</i>	<i>5</i>	<i>"</i>	<i>Pb (Kals Oxy)</i>				<i>Lead acetate added, but no good. Then CuSO₄ added and Zn formed immediately.</i>							

Experimenter *W. H. Kamp*

Missouri School of Mines and Metallurgy

FLOTATION LABORATORY.

ORE

Table Sludge from Golden Rod Mining and Smelting Corp. Tar River, Okla. Zn = 12.77%

*Time = 15 to 20 minutes
Ore = 700 grams
Water = 3500 grams
Speed of Mach. = 700 R.P.M.*

Test No	OIL			REAGENTS Pounds			REMARKS.	Conc		RESULTS		Tail		Per Ct. Ext.
	No.	Amt. Drops	Kind	Kind	Amt.	$CuSO_4$		Oil	Wt. gm.	Per Ct.	Wt. gm.	Per Ct.	Wt. gm.	
1	19	5	Crude Pine				.5							
	117	5	Creosote	$CuSO_4$	70	2.1	.4	Better Conc. after adding # 117	134	56.57			2.5	77.5
2	H.T.	10	Newport Chem Wks.				1.0	Good Conc. Dry froth until all Zn is off, then wet.						
	117	1	Creosote	$CuSO_4$	50	1.5	.08	Brought over a dirty concentrate	128	58.53	34	46.93	0.88	93.0
3	H.T.	5	Newport Chem Wks.				.5	$CuSO_4$ added 10cc. at a time up to 60 cc.						
	X.Y.	5	"	$CuSO_4$	60	1.8	.5	Good concentrate after all $CuSO_4$ added	152	56.67	12	36.67	0.91	92.6
4	X.Y.	5	"	$CuSO_4$	60	1.8	.5	Good Conc. All $CuSO_4$ added at one time	124	59.16	45	39.47	0.66	94.0
5	H.T.	10	"	$CuSO_4$	30	0.9	1.0	Fairly good Conc. but not enough weight. Not enough $CuSO_4$ to bring up all Zn, therefore a poor extraction	48	54.70	39	41.44	8.12	44.0
6	H.T.	10	"	$CuSO_4$	40	1.2	1.0	Good Concentrate but not enough.	98	54.91	20	43.60	5.09	65.0

Experimenter *W.H. Kamp*

Missouri School of Mines and Metallurgy

FLOTATION LABORATORY.

ORE

*Table Sludge from
Golden Rod Mining
and Smelting Corp.
Tar River, Okla.
Zn = 13.77%*

Time = *15 to 20 minutes*Ore = *700 grams*Water = *3500 grams*Speed of Mach. = *1700 R.P.M.*

Test No	OIL			REAGENTS		Pounds		REMARKS.	Conc.		RESULTS		Tail	Per Ct. Ext.	
	No.	Amt. Drops	Kind	Kind 1.0%	Amt. cc	CuSO ₄	Oil		Wt. gm.	Per Ct.	Wt. gm.	Per Ct.			
7	A.T.	10	Newport Chem. Wks.	CuSO ₄	50	1.5	1.0	Good Concentrate	120	57.91	27	43.30	-	2.10	83.0
8	A.T.	10	"	"	60	1.8	1.0	" "	130	58.74	25	40.92	-	1.31	88.5
9	A.T.	10	"	"	70	2.1	1.0	" "	130	58.33	27	39.16	-	1.40	88.0
10	A.T.	10	"	"			1.0								
		15	Pine Oil	"	40	1.2	0.16	Good Conc. Better than with A.T. mixture alone. Fairly good conc.	124	57.91	12	41.14		2.80	78.5
11	X.Y.	10	Newport Chem. Wks.	"	30	.9	1.0	More froth than A.T.	72	56.05	42	43.01		5.21	60.0
12	X.Y.	10	"	"	40	1.2	1.0	Good Concentrate but not enough	94	57.81	31	45.79		4.03	70.0
13	X.Y.	10	"	"	50	1.5	1.0	Good Concentrate	120	58.22	14	44.34		2.75	78.0
14	X.Y.	10	"	"	60	1.8	1.0	" "	128	58.64	32	38.44		1.31	89.0
15	X.Y.	10	"	"	70	2.1	1.0	" "	150	57.08	17	26.31		1.22	92.0
16	A.T.	5	"	"			.5								
	X.Y.	5	"	"	30	0.9	.5	Poor Concentrate Not enough CuSO ₄	No Analysis						
17	A.T.	5	"	"			.5								
	X.Y.	5	"	"	40	1.2	.5	Better Concentrate	97	58.64	48	43.60		2.78	81.0
18	A.T.	5	"	"			.5								
	X.Y.	5	"	"	50	1.5	.5	Good Concentrate	112	54.49	13	36.36		4.23	70.0
19	A.T.	5	"	"			.5								
	X.Y.	5	"	"	60	1.8	.5	" "	138	58.74	18	37.40		1.11	91.0

Machine *Mineral Separation*

EXPERIMENT STATION

OPERATING DATA

Experimenter *W. H. Kemp*

Missouri School of Mines and Metallurgy

FLOTATION LABORATORY.

ORE *Table Sludge from Golden Red Mining and Smelting Corp. Tar River, Okla. Zn = 13.77%*

*Time = 15 to 20 minutes
Ore = 700 grams.
Water = 3500 grams.
Speed of Mach = 1700 R.P.M.*

Test No	OIL			REAGENTS				REMARKS.	Conc.		RESULTS		Tail		Per Ct. Ext.
	No.	Amt. Peps	Kind	Kind 1.0%	Amt. cc	Pounds CuSO ₄	Pounds Oil		Wt. gm.	Per Ct.	Wt. gm.	Per Ct.	Wt. gm.	Per Ct.	
20	X.Y.	10	Newport Chem. Wks.	CuSO ₄	60	1.8	1.0	Good Concentrate	132	58.94	27	40.40	-	0.97	92.0
21	H.T.	10	"	"	60	1.8	1.0	" "	124	59.36	22	47.96	-	1.61	87.0
22	H.T.	10	"	10.0%	10	3.0	1.0	" "	120	59.16	26	41.75	-	2.1	85.0
23	H.T.	5	"	"	20	6.0	.5	" "	150	58.64	12	32.93	-	0.58	95.0
24	H.T.	5	"	"	20	6.0	.5	Check on No. 23	148	58.64	14	31.50	-	0.61	95.0