1920

Milling practice of the Missouri-Kansas-Oklahoma field as it has developed in the past two years

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MILLING PRACTICE OF THE MISSOURI-KANSAS-OKLAHOMA FIELD

AS IT HAS DEVELOPED IN THE PAST TWO YEARS.

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

METALLURGICAL ENGINEER

Rolla, Mo.

1920.

Approved by Chas. J. Clayton,

Associate Professor of Metallurgy and Ore Dressing.

The writer has limited his subject to deal with the past two years as it is only the past two years that a great deal of research has been done in the field upon milling ideas and practices; but I will briefly give you the evolution of our present milling and concentrating practices by means of the following flow sheets:-

Flow Sheet Number I

is the old prospectors method of concentrating, and the writer wishes to emphasize the one fact, that this method of concentrating is to be respected at present. I know of several mining companies who now possess big idle mills as their monument to poor judgment or ignorance to the "mining business", because they had a small rich body of ore and could have made a great deal of money had they installed a concentrating system as shown below:

Hoisted Ore

Small Storage Bin
50 ton capacity

Blake Crusher

Cornish Rolls 18" or 24"

Two Rougher Hand Jigs

tails to tailing pile

Hutch

Two cleaning one lead

Hand Jigs

Hand jig

Tails

Zinc Concentrate

Lead Concentrates

I, personally, know of several companies operating at present upon a flow sheet as shown above, and I highly recommend this method of concentrating under the following conditions:

(1) During prospecting developing period.
(2) Allowable capital investment is limited, due:
    (a) limited ore body
    (b) " cash assets
(3) "Gouge" mining.

The above flow sheet was the original method of concentration in the bed Missouri camp.

Later Harz jigs were substituted for hand jigs and only within the past six or seven years has the concentration table been universally adopted throughout the district.

The present method of concentrating the ores of this district is still subject to a great deal of improvement in certain places, and after giving you the flow sheet of one of our latest mills, and a flow plan of another, I will discuss these points.

Exhibit "A" is a flow sheet of the concentration plant of the Oklahoma Woodchuck Mine. Since making this flow sheet, flotation has been installed, patterned after the Mascot,Fern,type of Mineral Separation patents.

Exhibit "B" is plan of the Victory Metal Company # Two.

Exhibit "C" is the tabulated results of a mill test made upon the work done by the mill plan shown in Exhibit "B" before the flotation was installed.

The writer requests the reader to thoroughly study these exhibits, as he has endeavored to make them, self explanatory, and to the student of metallurgy they impart more knowledge than any written description, and show completely the improvements of the past two years. As in any business there is an economics point which concentrating improvement and milling practices must stop. That is, the added improvement or concentrating equipment fails to realize for the investor. The money spent in this equipment is not returned to the capitalist by the increased production of the mill, or the increased efficiency of the concentrating plant, and after considering all methods of concentrating ore, do not lose sight of the one principal factor, that is, the quickest, most efficient and cheapest method of concentrating the

ore to realize the largest financial gain to the investor.

Often times undue criticism is made of the management for not installing equipment and likewise criticism is justified in some cases when praise is given for reasons stated in the preceding paragraph.

To the metallurgist who is to design a concentrating plant in the Oklahoma-Kansas district, I take this opportunity to warn him against the above stated errors. There are two main factors to deal with:

(A) Size of Ore reserves
(B) Character of Ore.

Do not fail to calculate your ore reserve and determine the character of your ore body before designing your concentrating plant. The extent of your ore body will tell you exactly how much money you can profitably spend in construction, and the character of your ore will aid the designer in his hardest problem, "The Flow Sheet."

A summary of the past two years in concentrating would be as follows:

1. The Harz jig still remains as the most efficient method of concentration. A Hancock jig is now being installed by the St.Louis Smelting and Refining Company. Hydraulic cones are being installed for dewatering, Harz jig tails, rahter than use the old revolving dewatering screen. The dewatering screen has an efficiency ranging from 30 to 60% while the Hydraulic cone varies from 70 to 90%.

2. A great improvement has been made in sand classification for sludge tables.

3. Slime losses has been decreased by installing of Dorr Thickeners with flotation or better slime table work.

Other improvements have been attempted of which Ball Mills was one. The writer knows of one installation of Hardinge Ball Mills to grind the "chats" produced in the different parts of the flow sheet and in this particular case the following results were recorded:

1. Ball Mills could not be fed to capacity, due to limited capacity of rest of mill.

2. First cost of installation of Ball Mills and power high.

3. Cost of operating Ball Mills high -- Hard Iron alone cost between 25¢ and 30¢ per ton of dry material ground.

4. Added revenue to the company due to increased production did not justify expenditure.

This does not mean that all ball mill installations would be a failure; as some mines may have a large ore reserve which is very "chatty" and a ball mill would be a profitable investment; but before making this installation know your problem thoroughly.

Another introduction to our concentration methods in the past two years is flotation. There are three types of machines in successful use at present, namely the

De Meier machine, which is a Mineral Separation "take-off" used by Eagle Picher Lead Company. No doubt this machine is successful, as I cannot realize a company of the magnitude of Eagle Picher using the machine for three years as they have, if it was unsuccessful.

The Standard Mineral Separation is second.

And third the Butchart Flotation Machine. The latter flotation machine is the same in basic principal as the K and K. There are more Butchart flotation machines in operation in this district than of any other design. This does not mean that the Butchart is the best and do not interpret the writer as being prejudiced to any one type of flotation. The following factors no doubt favor the Butchart;

1. Butchart is locally represented.
2. First cost less than other machines.
3. Cost of power less.
4. Floor space less.

The writer does not know how the efficiency of the Butchart compares with other flotation machines as operated in this district, and I do not believe any comparative tests have been made.

Most all flotation machine product in this district is put over a concentrating table to separate the galena and sphalerite. The tails of the table are always in closed circuit with the flotation machine.

A great many of our largest mining companies still refuse to install the flotation process of recovering values from the slimes, and I will state that some are justified in their action. The character of some ore is such that few slimes are made, or the ore

body does not justify the expenditure.

The average cost of installing a Butchart flotation system, complete with Dorr Thickener, power and building is approximately $9,000.00.

SLIME TABLE CONCENTRATION

An effort has been made by these whom have confidence in Slime Table concentration to increase the efficiency of this method of concentration; but the one hindrance to this method has not been rectified to the present time. Namely; the small capacity of a slime conventration table. Even the Dorr Thickener does not feed a pulp that allows the table to work efficiently upon a large feed. The writer has been informed that Mr. Boylon, of the James Concentrating Company, is perfecting a Rougher Slimes which will make a product of near 30% metallics, this product to be treated over slime tables. Your attention is directed to Exhibit "C".

In conclusion the writer wishes to call your attention to Exhibits "A", "B" and "C" accompanying this thesis. You are requested to carefully study the flow sheet, plan, and mill test.

The writer cannot close this paper without mentioning a few costs.

Approximate average cost at present time to construct a thirty ton per hour concentrating plant with gas power-plant to be built of galvanized iron.

Foundation	$ 1,750.00
Labor	17,300.00
Ground Equipment	3,300.00
Ponds	1,500.00
Machinery	23,000.00
Galvanized Iron Lumber and Building Hardware	22,500.00
Surface Improvements	12,000.00
	$81,350.00

An average cost of operation per ton of Rock Hoisted;

Mining	1.50
Milling	50
Administration	60
Taxes	
Prospecting & General	

The above cost does not consider depreciation and depletion.

I direct your attention to the cost of mining at present as a comparison with the pre-war cost averaging around $1.10 per rock ton. There is no reason to believe that the cost of $1.10 will ever return. The world's business is steadily going forward and the old cost of $1.10 is gone nover to return, and it is questionable if the total cost of $2.60 will not be past history before many months.

Respectfully submitted,

(signed) F.S.Elfred, Jr.

MILL EFFICIENCY TEST

ON

V I C T O R Y M E T A L C O M P A N Y

MILL #2

Test Run On

November 15, 16, 17, 1919.

Exhibit "C".

Mill #2 has been running on the tailings and coarse dump from the hand jigs ever since it began to operate. It was evident from the operation that we were loosing quite an amount of rich slimes. To determine the amount and quality of these slimes; the mill test was run.

While running the test for slimes, other samples throughout the mill were taken to give real insight into the work of the mill. All assays are given in terms of metallic zinc unless otherwise stated.

All weights are given in dry pounds per hour.

Sample #1

Jig tailings from 1.5 MM dewatering screen.

1/4 MM East side	2.75% Zinc	4.09% Blende
5/16 MM West side	2.66% Zinc	3.99% "

An equal amount of original samples was taken and screened as follows:

	% of Total	% Zinc
Plus 4 Mesh	17.00	2.84
6 "	32.60	3.05
10 "	35.60	3.35
20 "	10.40	2.62
Minus 20 "	4.40	3.35
	100.00	

Average Calculated Assay 3.03%

Sand and sludge tailings on coarse side of sludge mill.

4 Butchart Tables

Total Tailing	% of Total	5580 pounds per hour. % Zinc
Plus 28 Mesh	39.8	3.95
35 "	19.6	3.20
48 "	13.8	3.03
65 "	10.5	2.52
100 "	7.4	2.31
Minus 100 "	8.9	10.43
	100.0	

Calculated average assay 3.98% Zinc

The slime side of sludge mill samples were lost in Waring and Williams Laboratory. A calculation was made from tailing assays which you will please note in a later place in this test.

Table Number 1.

Feed	1725 pounds per hour % Total	% Zinc
Plus 10 Mesh		
20 "	13.16	5.26
35 "	34.50	6.05
Minus 65 "	24.44	7.04
	99.90	
Calculated average assay		8.86

Concentrates Table #1 61.10

Tails Table #1 2.90

Efficiency Formula

$$\frac{100x\ B(A-C)}{a(B-C)} = E$$

A Metallic Assay of Feed

B " " " Concentrates

C " " " Tailings

$$\frac{100 \times 61.10(8.86-2.90)}{8.86(61.10)-2.90)} = 70.62\%\ E$$

Table #2 1885 Pounds per hour

		% Total	% Zinc
Plus	20 M	11.65	4.96
	35	30.90	5.56
	65	23.40	6.00
Minus	65	34.00	16.70

Calculcated Average Assay 9.38%

Concentrates table #2 59.10

Tailings " #2 2.77

Efficiency by formula = 73.93%

Table #3 2175 pounds per hour

		% Total	% Zinc
Plus	20	11.20	6.04
	35	34.18	5.80
	65	23.80	8.70
Minus	65	30.80	19.00

Calculated Average Assay	10.60
Assay Concentrates Table #3	60.00
" Tailings " "	4.11
Efficiency by formula =	66.5%

Table #4

Because of Method of installing feed launders, it was impossible to get a tonnage sample on this table; but samples were taken without time and following results recorded.

Feed Table #4	13.60 % Zinc
Concentrates Table #4	58.80 " "
Tailings " "	3.92 " "
Efficiency by formula	88%

The above four tables are all of the coarse sand table.

SLIME SIDE OF SLUDGE MILL

TABLE #5

Feed	645 pounds per hr.
	% Total	% Zinc
Plus 65 Mesh	2.99	4.20
Minus 65 "	97.00	32.80
Calculated average Assay		31.92
Concentrates Table #5	58.50 Estimated	
Tailings Table #5		4.50
Efficiency by formula		93.2%

Table #6

Feed 432 pounds per hour

	% Total	% Zinc
65 Mesh	00.90	5.85
Minus 65 "	99.10	23.50

Calculated Average Assay 23.35

Concentrates Table #6 60.90

Tailings Table #6 6.35

Efficiency by formula 78.60

Feed Table #7

610 pounds per hour

	% Total	% Zinc
Plus 65 Mesh	0.23	4.37
Minus 65 Mesh	99.77	18.25

Calculated Average Assay 18.22% Zinc

Assay Concentrates 59.80

Assay of tailings 5.25

Efficiency by formula 78.10

Table #8

335 pounds per hour

	% Total	% Zinc
Plus 65 Mesh	0.63	6.40
Minus 65 "	99.37	24.30

Calculated Average Assay 24.19

Assay Concentrates Table #8 60.10

Assay Tailings " " 7.25

Efficiency by formula 79.70

Table #9

	200 Pounds per hour % Total	% Zinc
Plus 65 Mesh	9.38	7.20
Minus 65 "	90.60	15.80
Calculated Average Assay		14.97
Assay Concentrates Table #9		58.40
" Tailing " "		8.35
Efficiency by formula		52.70

Table #10

	175 pounds per hour % Total	% Zinc
Plus 65 Mesh	2.75	6.40
Minus 65 "	97.25	15.85
Calculated Average Assay		15.60
Assay Concentrate Table #10		59.10
" Tailings Table #10		11.20
Efficiency by formula		34.83%

Average Assay of table concentrate is 59.50% Zinc, Iron 1.40 and the lead varied from 1.50 to 2.00% in the concentrates.

OVERFLOW

OF

-V- TANK IN SLIME SIDE OF

SLUDGE MILL

220 pounds per hour.

		% Total	% Zinc
Plus	65 Mesh	7.00	4.20
	100 "	1.02	4.93
	150 "	1.72	5.04
	200 "	2.55	16.40
Minus	200 "	87.80	10.94

Calculated Average Assay 10.40% Zinc

Overflow Sand Settling

Tank

Tonnage Sample taken about one hour before a new tank was to be broken. Assay samples over the period of the entire test.

1275 pounds per hour

		% Total	% Zinc
Plus	65 Mesh	none	
	100 "	.36	12.08
	150 "	.36	11.56
	200 "	.54	11.20
Minus	200 "	99.80	10.20

Calculated Average Assay 10.25 Zinc

As I previously stated that the sample of the slime side of sludge mill was lost. It was not lost before the tonnage had been calculated.

Slime table tailings was 675 pounds per hour.

The writer calculated the average tailing assay from the table sample which result was 6.35% Zinc.

Calculations on Slimes

675 pounds, assaying 6.35% Zinc = 42.86 pounds zinc per hour = 63.30 pounds Blende.

-V-Tank 220 pounds Assaying 10.40 = 22.88# Zinc = 34.32# Blende

Settling Tank 1275 pounds assaying 10.25 = 130.70# Zinc
= 196# Blende
Blende 293.6#

The 293 pounds of blende per hour would be the feed to the Dorr Thickener, which on a conservative estimate would recover 60% or 175 pounds blende per hour.

175 x 10 = 1750 pounds blende per 10 hour
175 x 10 = 3500 " " " 20 "

3500 pounds blende at $40.00 per ton = $70.00 Additional Revenue.

This calculation is made upon the surface tailing dump. Just what the results will be when the ground dirt enters the mill, I am unable to state; but I can positively assert it will be equal to the above calculations and

all reasonable deductions , will cause one to estimate it much higher than the above calculations

Our concentrates from the surface rock is only assay 54% Zinc. This is due to "Chatty Ore" as the following screen analyses will show:

Cleaner Jig Concentrates

	% Total	% Zinc
Plus 10	38.3	49.75
20	17.5	56.70
40	19.4	57.50
65	17.9	54.30
100	4.5	54.00
100	2.5	55.70
	100.00	
Calculate Average		53.60

The above sample was taken over a period of 48 hours and 200 grams from each hutch made into a composite sample for the screen analyses. Later grab samples were taken of each hutch separate, and the hutch product assayed as follows:

Cleaner Jig

	% Zinc
Hutch #1	60.40

	% Zinc
Hutch # 2	56.40
" 3	57.10
" 4	52.80

Calculated average 56.90 %

Using Hutch 1 and 2 as giving 30% each of total concentrates made on jig and 3 and 4 Hutch as 20% Each.

I believe the screen analyses is nearer to correct as our car sample assays bear this out

"Sand Jig"

200 Grams from each hutch was taken for a screen analyses.

	% Total	% Zinc
10 Mesh	1.77	56.30
20 "	5.42	50.00
40 "	16.40	51.40
65 "	38.30	46.40
100 "	20.40	49.40
Minus 100 "	17.70	55.00

Calculated Average Assay 49.5

The samples were taken the same as on cleaner jig; likewise, hutch samples were later grabbed which assayed as follows:

Hutch #1	52.90 %	Zinc
2	55.10 "	"
3	52.00 "	"
4	46.60 "	"

Calculated Average 52.35% Zinc

I again believe that the screen analyses average is nearer to correct for reasons previously stated.

OPERATION RECORD

Victory Metal Company # 2

	Jig Room				Sludge Mill			
Date	Tons Rock	Hours	Tons Zinc	Tons Lead	Hrs.	Tons Zinc	Tons Lead	Total Tons Lead & Zinc.
11-15	235	19	34.5	5.3	19	8.9		48.7
11-16					10	2.7		2.7
11-17	171	14¼	18.6	3.3	20	7.7		29.6
Total	406	33½	53.1	8.6	49	19.3		81.0

From operation record above the average feed per hour was 12 tons; and average recovery is equal to 20%. Therefore, 20% of 12 tons equal 2.40 tons per hour of concentrates, which is 9.60 tons tailings per hour of which 3 tons comes from the sludge mill as follows:

		% Total Sludge Test
5580 pounds	4.00% =	89.4
675 "	6.35% =	10.6

Calculated total sludge tailing 4.25%

		Total Tailings
3 ton assay	4.25% Zinc	31.2
6.6 " "	3.00% "	68.8

Calculated average mill tailing = 3.40

The Preceding above calculated average mill tailing does not take into consideration the over-flow slime losses, which should be. The calculation on the total losses is as follows:

		% Zinc	% Total
5580 pounds	sludge coarse tailings	4.00%	29.00
675 "	" Fine tailings	6.35	3.52
1200 "	Sand Tank overflow	10.40	6.25
200 "	V Tank overflow	10.40	1.04
11545 "	Coarse Jig Tails	3.00	60.15

Calculated average total loss, 3.93% Zinc of feed. No assays were made of the mill feed; but having the

total percentage of recovery and the total percent of our losses we could easily calculate the assay of the mill feed, which in this case is equal to 25.9% blende. Its equivalent in metallic zinc being 17.35% Zinc. Therefore, having the assay of the mill feed and the mill tailings and knowing the percentage of zinc in our concentrates we can calculate the total efficiency of the mill, which is as follows:

$$\frac{5400\ (1735 - 3.93)}{17.35\ (54.00-3.93} = 83.4\%\ E$$

Respectfully submitted,

(Signed) F.S.Elfred, Jr.