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SOME ACCOMPLISHMENTS THROUGH SIMPLIFICATION OF
CONCENTRATOR FLOW-SCHEME.

by

Ralph Augustus Conrads.

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

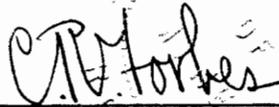
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ENGINEER OF MINES
(MINE ENGINEERING COURSE)

Rolla, Mo.

1923.

Approved by



Professor of Mining.

THESIS. Some accomplishments through simplification of concentrator flow-scheme.
Conrads. 1923.

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LIST OF WHITE-PRINTS OF FLOW-SCHEMES,
TABULATED DATA AND SCREENING ANALYSES.

Flow sheet of Compañia Minera del Mirasol Concentrator, January 1st, 1921.

Compañia Minera del Mirasol - Re-arrangement of Flotation Flow-sheet of Concentrator, January 30th, 1921.

Flow-sheet - Cia. Minera del Mirasol S.A. - Concentrator, July 20th, 1921.

Flow-sheet of Concentrator - Cia. Minera del Mirasol, March 10th, 1922.

Flow-sheet of Concentrator - Cusi Mining Company, September 1st, 1922.

Cia. Min. del Mirasol, S. A. - Milling Costs per ton milled, 1921.

Cia. Min. del Mirasol, S. A. - Milling Costs per ton milled, 1922.

Screening Analyses and Cumulative logarithmic diagrams of the following (The Cusi Mining Company - September 1922):

Gates Breaker Product.

Trommel Over-size.

Trommel Under-size.

Symons Crusher Product.

6' x 4-1/2' Ball-mill Feed.

LIST OF WHITE-PRINTS OF FLOW-SCHEMES,
TABULATED DATA AND SCREENING ANALYSES.

(Continued)

6' x 4-1/2' Ball-mill Discharge.

Tube-mill Feed (Sand Discharge Dorr Classifier).

Tube-mill Discharge.

Slime Discharge of Dorr Classifier (Flotation Feed).

Tabulation of Mill Assays and Extraction by Months,
from July 1921 to November 1922.

SOME ACCOMPLISHMENTS THROUGH SIMPLIFICATION OF
CONCENTRATOR FLOW-SCHEME.

Invention and developments in both processes and machinery, in recent years, have made possible a very marked simplification in the design and operation of concentration plants. Certainly there yet exist the difficult, the quite - if not entirely - impossible ores which must be left for further refinements of processes already in use, further metallurgical research and invention or more favorable economic conditions.

In a district that has produced high-grade shipping ores for many years and where no concentration has been practiced in recent times, it is quite easy to understand why a company which, as an afterthought, contemplates the concentration of their lower grade ores, would probably anticipate and in the original design of the plant, provide for many possible difficulties that might be encountered but many of which may never be realized to the extent of affecting the efficiency of operation.

In attempting to improve upon a scheme already in operation and where it is highly desirable, or absolutely necessary, to maintain production while any changes are being made, it sometimes happens that the mistake is made of working on the effect rather than the cause. To do otherwise usually results in higher costs and probably a sacrifice in percentage of extraction during the period of reconstruction or re-arrangement. This, in part, will account for the high milling costs and the low extraction during November and December 1921. It also is partly responsible for the length of time required to make the several changes, as it was necessary to keep the mill in operation.

The writer came to The Cusi Mining Company in the last days of October 1921. The property and the district are just such as previously described, this company having been a high-grade producer for some years and the mill was built to handle the lower grade of mine ores and an accumulated mine dump.

The economic minerals are argentite, argentiferous galena and tetrahedrite, some chalcopyrite, associated pyrite and some minerals of Zn. and Mn. but in

relatively insignificant quantities. The country rock is rhyolite and the ore treated is a mixture of quartz, fault-gouge, attrition breccia, vein minerals, rhyolite broken with the ore, particularly in mining the narrower veins, etc.

The writer considers the best method of setting forth the changes made during the period of his incumbency, as General Superintendent of the property, to be that of a chronology, amplified by explanations and accompanied by white-prints of flow-schemes, tabulations of milling costs, etc., by reference to which not only will changes in flow-scheme be easily followed but actual results may be seen. As a matter of comparison, the chronology will date back to the original starting of the plant in June 1920.

The property was operated for several years by, and under the name of the "Compañia Minera del Mirasol S.A." On May 1st 1922 that arrangement was terminated and operations subsequent to that date have been conducted by "The Cusi Mining Company".

Attention is called to the fact that the accompanying prints of flow-schemes do not include the coarse-crushing department. This consists of:

- 1 - Gates Gyratory Crusher (Size: #5-K);
 - 1 - Trommel (40" diameter, 8' long) with round holes of 1" diameter;
 - 1 - 24" Symons Disc Crusher; .
- Necessary Belt Conveyors.

The product of the gyratory crusher goes directly to trommel. Oversize of the latter goes to Symons Disc Crusher, the product of which joins trommel under-size and is conveyed to mill bins.

It should be mentioned that throughout the greater part of 1921 a high proportion of dump ore was treated. This amounted at times to about 50% of the mill feed. After continuing on this basis through November and December 1921, the amount of this material was greatly reduced and was finally eliminated when it's detrimental effect was definitely shown and another method was found for the profitable handling of a portion of the dump ores.

Chronology:

- 1920 - June. Mill was first put into operation.
- Dec. 8. Mill shut down.

The flow-scheme for this period was essentially as shown on white-print of flow-scheme dated January

1st, 1921 except that the four Callow cells were not in operation. The records show that the flotation feed averaged 25% to 35% solids and that the amount of soda-ash used was necessary to control the froth and hold the grade of concentrate up, even to the low point that was reached. Due also to the practice of thickening flotation feed, it was impossible to treat an average of more than 110 dry metric tons per 24 hours.

Oils and reagents used: (per dry metric ton of ore).

Richmond Fuel Oil - - - - -	0.74	kilos.
Cleveland Cliffs Creosote #2 -	0.56	"
Soda-ash - - - - -	2.20	"
Lime - - - - -	19.77	"

Summary of mill results:

	Assay in kilos Ag.
	per dry metric ton.
Table Concentrate - - -	10.827
Flotation Concentrate -	9.678
Tailing - - - - -	0.133
Mill Heading - - - - -	0.602

Total extraction amounted to 79%, of which 17.8% was credited to tables and 61.2% to flotation.

1921 - March 21. Mill operation resumed.

Flow-scheme same as shown on white-print of flow-scheme dated January 30th, 1921, except that a part of the Dorr Classifier overflow went directly to the distributors feeding 4 Hynes' roughing machines and the remainder went to Dorr Thickeners, the underflow of which was returned to same distributors. The froth from the 4 - 80 disc Hynes' roughers and the 4 Callow roughers, was returned to 2 - 50 disc Hynes' machines for cleaning. After a few weeks of operation the entire overflow of Dorr Classifier was sent directly to the 4 Hynes' roughers. This scheme obtained until July 27. Four primary Callow cells put into commission. (See white-print of flow scheme dated July 20th, 1921.)

August 16. Dorr Classifier overflow to distributors feeding 4 Hynes' roughers, tailing from which went to 4 Callow roughers. All rougher froth to 4 Primary Callow cells for cleaning, tailing from which joined original feed to Hynes' roughers. This scheme eliminated the 2 - 50 disc Hynes' machines.

As mentioned previously, no radical changes were made during November and the early part of December 1921 but a great deal of experimentation was done, with the result that on

December 21 - Two Callow roughers were removed to permit of the installation of another 80 - disc Hynes' machine.

1922.

January 1. Mill operation was cut to two eight-hour shifts per day. This allowed eight hours of daylight for necessary mill repair work and reduced emergency shut-downs to a minimum.

January 3. Last two Callow roughers were removed and one new Hynes' rougher (80 - disc) was put into commission.

January 10. Another 80 - disc Hynes' rougher was put into commission. The two last installed Hynes' machines treating the tailing from the four 80 - disc primary Hynes' roughers.

January 17. The two 50 - disc Hynes' machines were put into commission, treating all rougher froth and replacing the four Callow cleaning cells.

March 11. The use of Wilfley tables was entirely discontinued, the Ball Mill discharge going directly to classifiers.

June 1. Changed mill shifts to two nine-hour shifts per day and no Sunday work. This effected a considerable saving in power costs. (Power is produced

locally, with cord-wood as fuel, and costs are high.)

July 18. Drag Classifier was cut out and the entire load handled by Dorr Classifier.

August 2. Eliminated the pumping of all of the Dorr Classifier overflow up to the distributors, by the installation of a four-way wier distributor feeding roughers directly.

August 9. Cut out concentrate elevator, replacing it by centrifugal pump.

October 31. Another 80 - disc Hynes' machine was put into commission, to treat the entire mill tailing. The concentrate from this machine will, of necessity, be of low grade, perhaps averaging not over 2.5 or 3.0 kilos Ag. per ton. It's operation is entirely separate from the mill scheme and it's concentrate is being handled as a special low-grade product, for direct shipment to smelter.

General remarks:

A considerable amount of experimentation with oils was done from November 1921 to February 1922. This resulted in the use of Mexican Crude Oil and "Forest Products Chemical Company's Creosote #7". The average consumption of these oils being: (per dry metric ton of ore)

Mexican Crude Oil - - - - - 0.40 to 0.50 kilos;

Forest Products #7 Creosote - - 0.25 to 0.35 " .

Pine oil has been found to be generally unnecessary, although the use of Pensacola Tar & Turpentine Co's. #100 Pine Oil is resorted to on rare occasions when the additional frothing oil is necessary.

The percentage of solids in flotation feed is maintained at 19%, with practically no variation.

It will be noted that mill costs went up from \$2.13 per ton in October 1921 to \$3.02 per ton in November and \$2.98 per ton in December. (See under "Total Mill Summary" on white-print of "Milling costs per ton milled" for 1921.) A further analysis will show that a heavy tonnage (for this plant) had been treated during the four months previous to November 1921 and the condition encountered will be apparent by a study of the particular items of cost that were increased, which were essentially those of labor and supplies. In other words, they were necessary expenses to get the plant into proper condition for more economic and efficient operation. The effect of this expenditure may be seen by comparing costs during 1921 with those of 1922.

The elimination of elevators, screens, concentrating tables, drag classifier, etc., resulted certainly in a great economy in power and both operating and repair labor and, at the same time, the Ag. extraction was very consid-

erably increased by the changes effected.

In the analysis of costs, attention is called to the reduced tonnages treated during 1922. This was due to uncontrollable circumstances (apart from the mill). Under a reduction of tonnage the natural expectation is an increase in costs per ton, assuming equal or similar conditions of operation. In this connection it may be well to mention that the increase in extraction is in no wise due to the reduction of tonnage treated, because of the fact that the tonnage treated per hour of actual mill running time - in other words, the rate of flow through the plant - has not been decreased but, on the contrary, has equalled, and during certain periods considerably exceeded the average rate in the previous history of the mill.

The definite effect of the various improvements made, does not show up positively on the cost sheets until May 1922. This would have been apparent in the April costs, had it not been for a fire in the mine, which caused a suspension of operations for about ten days, during which time certain charges continued and had to be distributed through a very low tonnage for the month. Also there will be noted, a "Sundry" charge of \$0.21 per ton for tailing disposal in the

month of April 1922. This was an extra-ordinary
expense for dam construction that was charged direct-
ly against operation for the month.

Respectfully submitted,

Ralph Augustus Conrads.
Ralph Augustus Conrads.

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Company records of conditions and plant operations prior to November 1921.

Work done under the supervision of the writer, from November 1921 to December 1st, 1922.

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THE CUSI MINING COMPANY
Cusihiuriachic, Chih., Mexico.

Tabulation of -
MILL ASSAYS AND EXTRACTION BY MONTHS - FROM JULY 1921 to NOV. 1922.
(Assays in Kilos Ag. per dry metric ton).

<u>1921</u>	<u>Heading</u>	<u>Tailing</u>	<u>Concentrate</u>		<u>Percent Extraction</u>
			<u>Table</u>	<u>Flotation</u>	
July	0.629	0.086	7.974	6.950	87.4
Aug.	0.548	0.110	8.905	6.502	81.3
Sept.	0.620	0.119	8.255	5.303	82.4
Oct.	0.525	0.123	8.049	9.459	77.7
Nov.	0.523	0.107	9.543	8.048	80.6
Dec.	0.626	0.145	9.409	11.942	77.8
<u>1922</u>					
Jan.	0.819	0.101	8.618	12.418	88.5
Feb.	0.781	0.107	9.163	13.342	87.1
Mar.	0.811	0.118	9.606	15.211	86.2
April	0.904	0.088	_____	17.534	90.7
May	0.920	0.095	_____	21.405	90.0
June	0.707	0.080	_____	13.171	89.2
July	0.687	0.075	_____	12.475	89.7
Aug.	0.713	0.078	_____	12.125	89.7
Sept.	0.965	0.113	_____	17.673	88.9
Oct.	0.743	0.094	_____	13.508	88.0
Nov.	0.730	0.084	_____	13.794	89.0