REPORT NO. 254

Concentration of a lead ore from the Forbes Galena Mine, Perth Road, Ontario

by C. S. Parsons

Shipment: A shipment of 1 car, 80,000 pounds of lead ore was received August 26, 1926 from the Forbes Galena Mines Ltd. Perth Road, Ont. The property is more generally known as the Frontenac lead mine

Characteristics and analysis :6 The ore contains galena associated in a calcite gangue with pyrite and small amount of zinc blend The pyrite is present in sufficient quantity to interfere slightly with the concentration of the ore. The analysis of the car load was a Lead 2.03 per cent

Purpose of tests: The following mill test was conducted to determine a suitable flow sheet for the concentration of the ore which would utilize, with as few additions as possible, the equipment in the mill already on the property.

Experimental tests: The ore was crushed by jaw crusher and rolls set at ½ inch. A sample was cut by a Vezin sampler taking a tenth cut. This sample was reduced by grade crushing and division until a sample for analysis was obtained. The roll discharge passed over a set of three slotted screens, 1/4, 1/8, and 1/16 inch. The +¼ mesh was held until all the shipment had been crushed, and was then passed through the rolls again. The -¼+1/8 obtained from this recrushing was mixed with the -¼+1/8 obtained from the primary crushing. The -1/8+1/16 and -1/16 from the recrushing was sampled, weighed, and run separately from the corresponding sized obtained from the primary crushing. This accounts for portions marked 1 and 2 in the results of the tests. No. 1 is the portion obtained by primary crushing, and No. 2 by recrushing operation.

Table No. 1 - gives the weights and analyses of the sized products to be concentrates.

Table No. 2 - gives results of jigging the -¼+1/8 material

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Table No. 3 - gives the results of jigging the two portions -1/8+1/16

Table No. 4 - gives the weights and analyses of the two -1/16 products.

Table No. 5 - gives the results of tabling No. 1 portion -1/16

Table No. 6 - gives the results of classifying and tabling No. 2 portion -1/16 (see notes on operation)

Table No. 7 - gives the results of a table test made on the rejects of the head sample all crushed to 20 mesh. This test was made to check the head sample.

Table No. 8 - contains a summary of all the concentrates produced during the tests.

Table No. 9 - contains a summary of the Hutch products from the jig which were not retreated.

Table No. 10 - contains a summary of all middling products which were not retreated

Table No. 11 - contains a summary of all tailing products

Table No. 12 - is a balance sheet of the tests on the entire shipment

Ottawa, Oct. 19, 1926

~~PRELIMINARY~~ REPORT No 254

Concentration of a lead ore from the Forbes Galena Mine Ltd., Perth Road, Ont.

Table No. 1

Product	Weight lbs.	Weight %	Analysis Pb. %	Percent of values	Remarks
Heads	79,647	100	2.03		
-¼+1/8	13,057	17	1.47	11.9	Difference between weights
-1/8+1/16	30,063	39.2	2.08	38.6	of heads and totals due
-1/16 (1)	14,982	19.5	2.28	21.1	to material used for
-1/16 (2)	18,635	24.3	2.47	28.4	sampling.
Total	76,737	100		100.0	Calculated head - 2.11 % Pb

Table No. 2
Jig details. -¼ + 1/8

Feed	13,057	100	1.47		
Concentrate	147	1.13	82.91	74.2 Recovery	Jig bed used to bed
Hutch	36.5	0.27	17.13	3.7 Recovery	next size, hence differ.
Middling	124	0.95	15.89	12.0 "	ence between head and
Tailing	12,749.5	97.65	0.13	10.1 "	calculated head
Totals	13,057	100		100.0	

Table No. 3
Jig details -1/8 +1/16

1st.portion	16259	54.08	1.95	51.0	
2nd. "	13804	45.92	2.20	49.0	
Total	30063	100		100.0	
Concentrate	626.5	2.08	84.25	84.2 Recovery.	
Hutch	88.0	0.29	38.93	5.4 "	
Middling	178.5	0.59	13.61	3.9 "	
Tailing	29,1700	97.04	0.14	6.5 "	
Total	30063	100		100.0	

Table No. 4
Details -1/16 - Tabled

1st portion	14,982	44.57	2.28	42.6
2nd "	18,635	55.43	2.47	57.4
Total	33,617	100		100.0

Table No. 5
Tabling 1st.portion of -1/16

Heads	14,982	100	2.28		
Concentrate	442.5	2.97	78.83	93.2 Recovery	
Middling	40.5	0.26	21.61	2.2 "	
Tailing	14,499	96.77	0.12	4.6 "	
Total	14,982	100		100.0	

Product	Weight lbs.	Weight %	Analysis Pb. %	Percent of values
Table No. 6				
Tabling 2nd. portion of -1/16				
Heads	18,635	100	2.47	100.0
1st spigot conc.	321	1.72	80.71	63.1
" " midd.	136	0.73	9.36	3.1
2nd. " conc.	53	0.28	73.37	9.3
" " midd.	367.5	1.97	8.50	7.6
Slime conc.	38.5	0.21	78.63	7.5
" midd.	70	0.38	6.78	1.2
Tailing	17,649	94.71	0.19	8.2
				100.0
Totals	18,635	100		
Table No. 7				
Tabling rejects from sampling				
Concentrate	2650	3.6	62.69	90.2
Middling	2.75	0.4	8.50	1.4
Tailing	712.75	96.0	0.22	8.4
				100.0
Total	742.00	100		
Table No. 8				
Concentrates -				
Jig -¼+1/8	147.0	8.9	82.91	9.1
" -1/8+1/16	626.5	37.9	84.25	39.3
Tabling -1/16(1)	442.5	26.7	78.83	26.0
" 1st spigot	321.0	19.4	80.71	19.3
" 2nd "	53.0	3.2	73.37	2.9
Slimes	38.5	2.3	78.63	2.2
Rejects	26.5	1.6	62.69	1.2
				100.0
Totals	1,655.0	100	Average of all concentrates	81.175%
Table No. 9				
Hutch products -				
-¼ +1/8	36.5	29.3	17.13	15.4
-1/8+1/16	88.0	70.7	38.93	84.6
				100.0
Totals	124.5	100	Average of Hutch products	32.543%
Table No. 10				
Middlings -				
Jig -¼+1/8	124.0	13.5	15.89	19.4
-1/8+1/16	178.5	19.4	13.61	23.8
Table -1/16(1)	40.5	4.4	21.61	8.6
" 1st.spigot	136.0	14.8	9.36	12.5
" 2nd. "	367.5	40.0	8.50	30.8
Slimes	70.0	7.6	6.78	4.7
Rejects	2.75	0.3	8.50	0.2
				100.0
Totals	919.25	100	Average of all middlings	11.062%
Table No. 11				
Tailings -				
Jig -¼ +1/8	12749.5	17.0	0.13	15.0
-1/8+1/16	29170.0	39.0	0.14	37.1
Table -1/16(1)	14499.0	19.4	0.12	15.9
" " (2)	17649.0	23.6	0.19	30.5
Rejects	712.75	1.0	0.22	1.5
				100.0
Total	74780.25	100	Average of all tailings	0.147%
Table No. 12				
Concentrates	1,655.00	2.14	81.175	84.3 Recov.
Hutch products	124.50	0.16	32.543	2.5 "
Middlings	919.25	1.18	11.062	6.3 "
Tailings	74,780.25	96.52	0.147	6.9 "
				100.0
Totals	77,479.00	100.00	Head sample from entire test	2.06%Pb

NOTES ON TEST - by J. S. Godard

Table No. 1 - Difference between weight of heads and totals due to material used for sampling.

Table No. 3
Table No. 4 Portion marked first portion came from re-crushing oversize on ¼ screen

Table No. 5 The concentrate, middling and tailing obtained by combining the respective products from all three tables. Head sample calculated from products was 2.51% Pb - excess lead over head sample due to clean up of elevator.

Table No. 6 The second portion was classified in a launder classifier the discharge from No. 1 spigot was fed to a Butchart ¼-size table, the discharge from No. 2 spigot to a Plot-O ¼-size table, the overflow from the classifier to a full size Wilfley table. The tailing was the combined tailings from all tables. A special sample was taken during the last quarter of the run which represents the grade of concentrate that may be expected under normal operation conditions. This sample assayed 80.30% Pb

Operation Notes - Two James automatic jigs were operated as follows: No. 1 made a concentrate, a hutch and a tailing. The tailing was fed to No. 2 which made a concentrate ~~which was returned to the feed of No. 1 jig~~, a hutch, and a final tailing. The -¼+1/8 size was jigged under the following conditions

No.1 jig - water 3 ft. head - ⅛" throw, about 260 r.p.m. 12 mesh screen on hutch

No.2 jig - water 2 ft. head - 3/8" throw, about 260 r.p.m. 12 mesh screen on hutch

The -1/8+1/16 size was jigged under the following conditions :

No. 1 jig - water 2 ft.head - 3/8" throw, about 260 r.p.m. 12 mesh screen on hutch

No. 2 jig - water 2 ft. head - ¼" throw, about 260 r.p.m. 12 mesh screen on hutch

Rates of feed to jigs. Ref. Table No. 2 2,380 lbs/hour
" " 3 1,700 "

NOTES ON OPERATION by C. S. Parsons

James jigs on -¼ +1/8" size : The jigs made an excellent separation on this size, producing a very high grade concentrate and clean tailing. A higher grade concentrate could have been made without affecting the tailing, by increasing the amount of middling. The jigs were operated in series. There was no difficulty in keeping the iron out of the concentrate

James jigs on -1/8+1/16" size: The jigs also made an excellent separation onthis size. The middling was made on the bed of the second jig. After the operation of the jig was adjusted, a clean hutch was obtained, but no clean up was made to separate the dirty hutch product from the clean, hence the grade of only 38.93% for the total hutch product as shown in table No. 3

Tabling the -1/16": A large amount of experimental work was done on this size before a flow sheet was developed, and classifiers and tables adjusted to work properly. Portion No.1 was the material used in making and trying out different flow sheets and machine adjustments. The first flow sheet used was as follows: The -1/16" material screened over a 24 mesh Callow belt screen, sending the -24 to a Fahrenwald classifier. The +24 mesh going to a quarter size Butchart roughing table. The siz spigot discharges of the classifier were grouped into two products, the coarse product was fed to a Plat-O quarter size table and the finer sizes product to a quarter size Wilfley table. The slimes were thickened in a

cone tank and fed to a standard Wilfley table. The roughing table treating the +24 mesh got the bulk of the feed and made an excellent separation. The large Wilfley handling the slimes also made a good separation, but the two quarter size tables handling the classified feed did not get sufficient material on them to enable a proper cut to be obtained between the lead and iron sulphides. The flow sheet was abandoned as being of no practical use to meet the local conditions at the mine.

A second flow sheet was tried using a Richards launder type classifier with two chambers, straight on the -1/16" material. It took considerable time to find the proper adjustments, but one was finally obtained which could be maintained without difficulty and which produced excellent results. This launder type classifier is a direct type pulsator and could be converted into a jig by placing a screen on the sorting column. A coarse spigot product from the classifier was tabled on the Butchart roughing table, an excellent separation being obtained. The classifier was adjusted to give a product containing all the coarse lead. The feed to the table under this condition was light, but very high grade and the bulk of the lead in the -1/16" size was obtained from this table. The spigot from the second classifier contained the bulk of the feed, the classifier being operated to de-slime only. The slimes were thickened in a cone tank. The spigot product from this second classifier chamber containing the bulk of the sands was low in lead. This was fed to the Plat-O table and at least 2/3 of the -1/16" material passed over this table. By loading the table in this way a very good separation was obtained. Unfortunately a number of adjustments had to be made during the run and it was not until the latter part of the run that a final and satisfactory adjustment was obtained. A sample taken during this period to represent grade of concentrate which could be expected under operating conditions - 80.30% Pb.

It is well to point out here that the results obtained on all tables could have been improved greatly if more material had been available to allow correct adjustments to be obtained. The various adjustments which had to be made were, size of plug to use in the spigot discharge of classifier, amount of water, etc. In connection with the tables, we were using the Plat-O table for the first time and had difficulty in obtaining a proper dividing device for cutting the concentrate from the middling at the edge of the table. Also we ran the table with too great a stroke for some time, causing the coarse sands to crowd over the concentrate. It was also found necessary to load the table heavily in order to make it work perfectly. The tables have a very large capacity on this class of material and at no time were we able to get a full load on them. Each of the ½-size tables would have taken a feed of over one ton per hour. We were feeding the classifier at a rate of 1½ tons per hour during the latter part of the test on portion No. 2. A head of 20 ft of water was used, the speed of the coarse compartment was 330 pulsations a minute, or 160 r.p.m. A ¾" opening in the plug on the coarse and ½" for the fine discharge was used. The coarse classifier had a 2½" diameter sorting column, the fine classifier a 4" diameter sorting column. As said above, this type of classifier handled the -1/16" size (slotted screen) feed perfectly. An 8 ft. diameter cone was used for thickening the slime overflow. This gave a clear water overflow. Table No. 6 shows the results of the operation on portion No. 2

Table No. 13 is given so that a balance may be struck and enable a calculation to be made to check the original head sample. No attention should be given this table in regard to indicating separations, as the products obtained are a mixture of a number of different flow sheets.

GENERAL DISCUSSION: The flow sheet recommended is as follows:

Crushing to -¼", sizing on +1/8 and on 1/16" This gives two jig sizes In order to obtain capacity on the jigs and still make a separation between the iron and the lead, this screen ratio of 2 is believed to be necessary. The -1/16" size fed to two hydraulic classifiers

of simple construction. This gives three table sizes, coarse, medium, and slime overflow. The slime overflow to be thickened in a cone tank. The classifiers to be adjusted to give the proportions as described above. The middling from the jigs and tables to be re-ground and returned with the original feed.

This flow sheet can be adapted to the present mill without any radical changes being necessary, and no additional machinery will be required except the construction of two simple hydraulic classifiers which can be made on the job.

The tables should be loaded as heavily as possible and two spigot products seems all that are necessary in the way of classification. The two small Richards jigs at present at the mill and not in use could be put in operation to take care of the additional jig size, either the -¼+1/8 or the -1/8+1/16 depending on the relative capacity of the jigs now in used and the two which are not.

It is my opinion that the tables will handle the -1/16" material provided they receive a properly classified feed. The present Richards inverted type classifier does not give such a feed, hence the difficulty with the tables.

The suggestion of taking out the coarse lead before tabling, by classifying in an hydraulic classifier and jigging this coarse classified product on the two Richards jigs at present not in operation, does not appeal to me as good practice, because in order to jig an unsized product, suction is necessary to effect a separation and there is no suction in a Richards jig. (See page 413, 314 and table 94 Richards text book of Ore Dressing for complex discussion on this point)

It might be possible to run the whole of the -1/16" material over the jigs to eliminate the coarse lead which at present blocks the inverted type classifier and then to the inverted type Richards classifier. The only trouble with this suggestion is that there might be too much water with jig tailings for the classifier to handle. Then again, the best practice seems to demand that two jig sizes be made, and such a suggestion would leave no jigs available for this practice and would necessitiate the purchase of additional jigs.