TR15_164_172

R.608. Tin recovery tests, Tyree Holdings, Razorback Mine, Dundas

PART 1. TIN RECOVERY TEST ON CURRENT TAILINGS

A four gallon drum of tailings currently produced at the Razorback mine was submitted to determine how much recoverable tin was still present in the tailings. The weight of the sample was about 50 lb.

TEST WORK

The sample was dried and riffled to produce a head sample. Part of the head sample was pulverised for tin assay and part was subjected to a sizing analysis and the size fractions were assayed for tin to determine the tin distribution.

The remainder of the sample was fed over the Geco hydraulic sizer to produce three spigot products and an overflow product.

The three spigot products were separately concentrated on the Deister laboratory table using the sand deck, and the overflow product was concentrated on the Deister table using the slime deck.

The four table concentrates were each dried and magnetically separated on the Rapid laboratory magnetic separator.

The four table tailings were subjected to screen analysis to give an idea of the size range of the products from the Geco hydraulic sizer.

RESULTS

The head sample assayed 0.28% Sn.

The sizing analysis and Sn distribution of the tailings are shown in Table 1.

Table 1. SIZING ANALYSIS AND TIN DISTRIBUTION

Fraction	Weight		Assay	Sn Distribution	
	%	% Cum.	% Sn	%	% Cum.
+25#	0.7	0.7	0.19	2.8	2.8
36#	3.5	4.2			
52#	8.4	12.6	0.14	4.1	6.9
72#	12.2	24.8	0.15	6.3	13.2
100#	17.1	41.9	0.19	11.3	24.5
150#	14.2	56.1	0.21	10.3	34.8
200#	13.0	69.1	0.27	12.2	47.0
C/S1	9.9	79.0	0.93	32.0	79.0
C/S2	7.3	86.3	0.40	10.1	89.1
C/S3	4.4	90.7	0.34	5.2	94.3
C/S4	2.2	92.9	0.23	2.4	96.7
C/S5	0.8	93.7			
C/S6	6.3	100.0	0.15	3.3	100.0
		Calculated Assay	0.29		

The results of the tabling and magnetic separation of the table concentrates on each size fraction from the Geco hydraulic sizer are shown in Table 2.

Table 2. TABLING AND MAGNETIC SEPARATION

Product	% Weight	Assay % Sn	Distribution % Sn
S1 TC N	0.085	60.9	13.3
S1 TC M	0.028	17.7	1.3
S1 TM	2.03	0.72	3.8
S1 TT	24.5	0.14	8.8
S2 TC N	0.106	60.5	16.5
S2 TC M/A	0.036	13.6	1.2
S2 TM	5.09	0.29	3.8
S2 TT	23.1	0.12	7.1
S3 TC N	0.091	60.9	14.3
S3 TC M/A	0.039	9.65	1.0
S3 TM	5.09	0.22	2.9
S3 TT	17.6	0.12	5.4
O/F TC N	0.059	64.5	9.8
O/F TC M/A	0.054	6.37	0.9
O/F TM	3.29	0.26	2.2
O/F TT	18.8	0.16	7.7

Table 3. SUMMARY OF RESULTS FROM TABLE 2

Product	% Weight	Assay % Sn	Distribution % Sn
Total TC N	0.34	61.4	53.9
Total TC M/A	0.16	10.9	4.4
Total TM	15.5	0.32	12.7
Total TT	84.0	0.13	29.0
Calculated Head	100.0	0.39	100.0

The sizing analyses of the four tailing products are shown in Table 4.

CONCLUSIONS

A concentrate assaying 61.4% Sn with a recovery of 53.9% can be produced by careful sizing of the feed with a hydraulic sizer and magnetic separation of the table concentrates from each size fraction.

A further 17.1% of the tin in the feed is present in the table middlings and the magnetics from the table concentrates. No attempt was made to recover this tin, but regrinding and retreatment could possibly recover about half of this tin, and lift total recovery to about 60%.

Agreement between the calculated head of the test sample and the head sample assay was not good and an error appears to have occurred in the riffling of the head sample. The test sample consisted of the bulk of the submitted sample less the small head sample, and therefore should be the more reliable.

Table 4. SIZING ANALYSES OF TAILING PRODUCTS

Fraction	S1		S2		S3		S4	
	% Weight	% Weight Cumulative	% Weight	% Weight Cumulative	% Weight	% Weight Cumulative	% Weight	% Weight Cumulative
+18#	1.2	1.2						
25	1.4	2.6	0.1	0.1				
36	14.4	17.0	1.7	1.8	0.1	0.1		
52	31.4	48.4	6.9	8.7	0.9	1.0	0.1	0.1
72	30.3	78.7	19.3	28.0	4.5	5.5	0.1	0.2
100	15.4	94.1	33.7	61.7	17.0	22.5	0.2	0.4
150			23.3	85.0	28.8	51.3	1.0	1.4
200			10.6	95.6	29.0	80.3	5.6	7.0
300					13.0	93.3	13.4	20.4
U/S	5.9	100.0	4.4	100.0	6.7	100.0	79.6	100.0

PART 2. TIN RECOVERY TEST ON OXIDISED ORE

A 44 gallon drum of oxidised ore from the Razorback Mine, Dundas was submitted for tin recovery tests. The weight of the sample was about 8 cwt.

TEST WORK

The sample was crushed to about 1/2 inch in size, and then quartered by riffling. The quarter sample was reduced in size by the laboratory Chipmunk jaw crusher until it passed a 1/8 in screen. This sample was again quartered by riffling. The reject portion at this size was set aside for test work, and the remaining portion was further reduced in size by pulverizing and in quantity by riffling to provide a head sample for assay.

A number of batch grinding tests at various times were conducted on 2 kg charges of -1/8 in ore at 67% solids to establish the grinding times necessary to provide the following size ranges. These are shown with the required grinding times.

Test N1	10%+ 52# -	5 1/2	minute grind
Test N2	10%+ 72# -	8	minute grind
Test N3	10%+100# -	13	minute grind
Test N4	10%+150# -	22	minute grind

Gravity concentration tests were carried out at each of the above grinds. Five 2 kg batch charges at each of the above grinding times were respectively bulked to provide the feeds for the gravity concentration tests *N1, N2, N3* and *N4*.

The ball mill product in each test was sized with the three spigot Geco hydraulic sizer. In tests *N1* and *N2*, the orifices controlling the amount of rising water in each spigot were unchanged. In test *N3*, the orifice to No. 1 spigot was removed and replaced by the orifice to No. 2 spigot.

The orifice to No. 3 spigot was unchanged. An orifice intermediate in size to those now fitted to No. 1 and No. 3 spigots, was fitted to No. 2 spigot. In test No. 4, the orifice to No. 1 spigot in the previous test was removed and replaced by the orifice to No. 2 spigot. The orifice to No. 3 spigot was moved to No. 2 spigot and a fine orifice was fitted to No. 3 spigot.

The Geco products in each test were concentrated on the Deister table using the sand deck, while the Geco overflow product in each test was concentrated using the slime deck.

The table concentrates from each spigot product in each test were dried and subjected to magnetic separation on the Rapid magnetic separator.

RESULTS

The head sample assayed 0.59% Sn.

The results of the concentration tests are shown in Table 5.

A weighted sample was prepared from the table middling and table tail from each spigot fraction and overflow product for each test and subjected to screen analysis to give an indication of the sizing of the spigot fractions and the overall size of the grind in each test.

Table 5. RESULTS OF CONCENTRATION TESTS

Product	N1			N2			N3			N4		
	% Wt	% Sn	Sn Distn	% Wt	% Sn	Sn Distn	% Wt	% Sn	Sn Distn	% Wt	% Sn	Sn Distn
S1 TC N	0.18	62.1	18.5	0.14	64.5	15.1	0.19	65.2	20.0	0.22	70.0	24.4
TC M/A	0.60	8.30	8.1	0.39	9.25	5.9	0.31	7.53	3.6	0.35	16.7	9.2
TM	5.6	1.23	11.3	6.2	0.71	7.3	4.6	0.76	5.5	1.9	1.33	3.9
TT	20.7	0.27	9.1	3.8	0.21	1.3	4.7	0.17	1.3	13.0	0.21	4.3
S2 TC N	0.07	65.5	7.3	0.11	67.6	12.7	0.12	64.4	12.5	0.05	67.1	5.5
TC M/A	0.17	4.77	1.3	0.19	6.39	2.0	0.17	4.29	1.2	0.16	5.58	1.4
TM	3.1	0.55	2.7	3.4	0.76	4.3	2.0	0.78	2.5	1.3	0.44	0.9
TT	8.4	0.15	2.1	15.6	0.18	4.6	13.1	0.21	4.3	6.1	0.19	1.8
S3 TC N	0.08	63.0	8.6	0.12	65.0	12.5	0.12	61.2	11.6	0.10	65.2	10.6
TC M/A	0.09	3.90	0.6	0.14	4.42	1.0	0.12	3.77	0.7	0.17	5.76	1.6
TM	2.8	0.60	2.8	2.5	0.64	2.6	1.9	0.69	2.1	4.1	0.41	2.7
TT	10.8	0.14	2.5	14.7	0.14	3.4	13.8	0.14	3.0	12.7	0.14	2.8
O/F TC N	0.07	51.6	5.7	0.08	50.5	6.4	0.09	43.4	6.5	0.06	60.2	5.8
TC M/A	0.12	1.95	0.4	0.12	1.57	0.3	0.14	0.98	0.2	0.10	3.66	0.6
TM	4.1	0.41	2.8	4.2	0.34	2.3	3.3	0.44	2.3	4.6	0.52	3.7
TT	43.1	0.23	16.2	48.3	0.23	18.3	55.3	0.26	22.7	55.1	0.24	20.8
Calculated Head	100.0	0.61	100.0	100.0	0.61	100.0	100.0	0.64	100.0	100.0	0.64	100.0
Assay Head		0.59			0.59			0.59			0.59	
Total TC N	0.40	61.1	40.1	0.45	63.0	46.7	0.53	60.2	50.6	0.44	67.2	46.3
Total TC M/A	0.98	6.53	10.4	0.84	6.72	9.2	0.75	4.88	5.7	0.78	10.4	12.8
Total TM	15.6	0.77	19.6	16.4	0.61	16.5	11.9	0.66	12.4	11.9	0.60	11.2
Total TT	83.0	0.22	29.9	82.3	0.20	27.6	86.8	0.23	31.3	86.9	0.22	29.7

Table 6. PER CENT WEIGHT DISTRIBUTION

Test	#	S1	S2	S3	O/F	
N1	+44	3.4				
	52	4.6				
	60	6.3	0.4			
	72	3.5	0.6			
	85	4.2	1.7			
	100	2.8	2.9	1.1		
	120		2.4	1.4		
	150		1.8	2.0		
	170			2.6		
	200			2.5		1.9
	240			1.8	C/S1	2.7
	300			1.1	C/S2	4.8
					C/S3	6.5
					C/S4	6.3
					C/S5	3.4
	U/S	2.3	1.9	1.3		21.8
	Total	27.1	11.7	13.8		47.4
N2	+44	0.9				
	52	1.7				
	60	3.0	0.9			
	72	1.7	1.3			
	85	2.0	3.4			
	100	0.9	4.6	1.9		
	120		3.6	1.9		
	150		2.6	2.5		
	170			2.9		
	200			2.9		1.7
	240			2.0	C/S1	2.6
				1.5	C/S2	4.5
					C/S3	6.7
					C/S4	6.9
					C/S5	3.7
	U/S	0.3	2.9	1.9		26.6
	Total	10.5	19.3	17.5		52.7
N3	+60	1.1				
	72	0.9				
	85	2.3	0.7			
	100	2.5	1.7	0.6		
	120	1.7	2.9	1.0		
	150	0.9	3.7	2.0		
	170		2.8	2.6		
	200		1.9	3.2		1.7
	240		0.9	2.4	C/S1	2.7
	300			1.8	C/S2	5.0
					C/S3	8.1
					C/S4	8.1
					C/S5	4.2
	U/S	0.4	0.8	2.4		29.0
	Total	9.8	15.4	16.0		58.8

Table 6 - continued

Test	#	S1	S2	S3	O/F	
N4	+85	0.7				
	100	1.4	0.1	0.1		
	120	2.4	0.3	0.1		
	150	3.6	0.6	0.3		
	170	2.9	1.1	0.9		
	200	2.3	1.8	2.4		0.3
	240	1.1	1.4	3.0	C/S1	0.6
	300		1.2	2.6	C/S2	2.8
					C/S3	7.2
					C/S4	8.8
					C/S5	4.8
	U/S	1.1	1.1	7.7		35.3
	Total	15.5	7.6	17.1		59.8

The figures in Table 6 are percentages of the total feed in each test.

From these sizing analyses it can be seen that the following grinds were achieved in the respective tests.

Test N1 8.0% +52#

Test N2 9.5% +72#

Test N3 9.8% +100#

Test N4 9.6% +150#

DISCUSSION

A summary of the results of table concentration is shown below:

	% Wt	*% Sn*	*Sn Recovery %*
N1 TC	1.38	22.4	50.5
N2 TC	1.29	26.4	55.9
N3 TC	1.28	28.0	56.3
N4 TC	1.22	30.8	59.1

These results show that both concentrate grade and recovery have improved as the ore has been ground finer. This suggests that the tin occurs as extremely fine particles and fine grinding is necessary for its liberation. The results also suggest that tin losses that could be expected to occur from overgrinding of some of the cassiterite in tests *N3* and *N4* have been more than compensated by better performance in tabling in these tests because of more closely sized feed from the Geco hydrosizer.

Table 7 shows the table middling Sn assays and Sn distribution for each Geco sizer product in each test.

Table 7

Geco Product	N1 % Sn	N1 Sn Distn	N2 % Sn	N2 Sn Distn	N3 % Sn	N3 Sn Distn	N4 % Sn	N4 Sn Distn
S1	1.23	11.3	0.71	7.3	0.76	5.5	1.33	3.9
S2	0.55	2.7	0.76	4.3	0.78	2.5	0.44	0.9
S3	0.60	2.8	0.64	2.6	0.69	2.1	0.41	2.7
O/F	0.41	2.8	0.34	2.3	0.44	2.3	0.52	3.7
Total	0.77	19.6	0.61	16.5	0.66	12.4	0.60	11.2

These figures show the decreasing trend in tin assay of the middling fractions as the Geco product becomes smaller in each test. There is also a decreasing trend in the tin assays in each spigot fraction across the series of tests as the grind gets finer. Distribution figures also tend to show the same trends. The results again emphasise the necessity for fine grinding.

Magnetic separation of the table concentrate enabled the Sn assay of the concentrate to be lifted to an acceptable sale grade. Table 8 shows the tin assays and distribution of tin in the magnetic fractions from magnetic separation.

Table 8

Geco Product	N1 % Sn	N1 Sn Distn	N2 % Sn	N2 Sn Distn	N3 % Sn	N3 Sn Distn	N4 % Sn	N4 Sn Distn
S1	8.30	8.1	9.25	5.9	7.53	3.6	16.7	9.2
S2	4.77	1.3	6.39	2.0	4.29	1.2	5.58	1.4
S3	3.90	0.6	4.42	1.0	3.77	0.7	5.76	1.6
O/F	1.95	0.4	1.57	0.3	0.98	0.2	3.66	0.6
Total	6.53	10.4	6.72	9.2	4.88	5.7	10.4	12.8

It can be seen that in each test, the tin assays of the magnetic fractions of the table concentrate decrease in content down through the Geco products. This is due in part to the presence of tin-bearing composites in the coarser fractions, and in part to mechanical entrainment of free cassiterite by magnetic particles, particularly in case of the first spigot, where the quantity of magnetic material in the table concentrate is comparatively large.

The tin in the tailing for each test shows no marked trend, in fact the tin in the total tailing has remained fairly constant. The head grade of the ore at 0.59% is probably lower than what would normally be mined. A higher head would result in higher recovery of tin in the concentrate, as it is anticipated that tailing assays would not vary appreciably with increase in head value.

CONCLUSIONS

The cassiterite in the oxidised ore is very fine and requires fine grinding for liberation.

Careful sizing of the ball mill product is required if satisfactory recoveries are to be obtained by tabling. A regrind mill should be incorporated in the table circuit to grind the middling from the tabling operation.

At a grind of 10% +150#, a table concentrate assaying 30.8% Sn with a 59.1% recovery can be produced. Magnetic separation is required to produce a sale grade of concentrate. This concentrate was upgraded to 67.2% Sn by magnetic separation with a total recovery of 46.3%. A second magnetic separation with or without regrinding should recover most of the 12.8% short fall in recovery.

At a grind of 10% +100# a final concentrate was produced assaying 60.2% Sn with a recovery of 50.6%. If half of the tin in the table middlings is recovered by retreatment after regrinding, and half of the tin in the magnetics is recovered by secondary treatment as outlined above, a recovery close to 60% could be expected.

It becomes a matter of economics whether the ore is finely ground with middling regrind, or more coarsely ground with provision for a larger regrind installation.