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R.704. Magnetic separation test on Razorback Mill concentrates

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This report deals with magnetic separator tests performed on a sample of crude table concentrate generated by milling Razorback mine ore in the existing plant which is described in Investigation R.631.

The concentrate production methods have been described in Investigation R.649.

The -150 µm fraction of the concentrate which assayed 18.2% Sn was used in this investigation.

The majority of the test work was conducted by Mr N. Moony of Minops Pty Ltd.

TEST WORK

Three major tests were performed on the samples. These were:

(a) Dry magnetic separation at very low feed rates with recleaning of magnetics on a Rapid high intensity dry magnetic separator. This test was conducted to obtain some idea of the optimum result obtainable.

(b) A series of tests using the Jones High intensity wet separator to establish the response of the material to this type of treatment and the conditions to give optimum results.

(c) A combination of wet magnetic separation and gravity concentration to establish overall recoveries obtainable of sale grade concentrates.

RESULTS

(a) N1 "RAPID" DRY MAGNETIC SEPARATION

7 kg of the crude concentrate was separated with retreatment of each magnetic product. The results were:

	% Mass	*%Sn*	*% Sn Distn*
M/A 1	1.4	6.2	0.4
2	40.5	1.4	3.1
3	0.2	0.7	0.1
4	12.1	2.2	1.4
N	45.8	38.2	95.0
Composite Head	100.0	18.4	100.0

(b) JONES HIGH INTENSITY WET MAGNETIC SEPARATOR TEST

Group 1, Tests N1 to N6 - Rougher separations

Fixed conditions

Plates:	Salient pole type
Plate gap:	4 mm
Wash water (measured with machine stationary in wash position)	18 *l*/min
Pulse	400 kPa
Feed rate:	2.8 kg/min
Feed dilution:	20% solids
Field current:	5 to 40 A range over six tests.

Results

Product	*% Mass*	*% SN*	*% Sn Distn*
N1 10 A			
M/A	11.9	8.7	5.6
M	9.2	17.7	8.8
N	78.9	20.2	85.6
Composite Head	100.0	18.6	100.0
N5 15 A			
M/A	14.6	7.7	6.1
M	10.3	16.1	9.0
N	75.1	20.8	84.9
Composite Head	100.0	18.4	100.0
N6 40 A			
M/A	21.2	9.9	11.6
M	13.5	13.8	10.2
N	65.3	21.7	78.2
Composite Head	100.0	19.7	100.0

Comment

The tests show an increasing mass rejection of magnetics with an increase in field current. Tin loss in the magnetics increases markedly between 15 and 40 A, possibly indicating less efficient washing because of the blanketing effect of the increased quantity of magnetics.

The results do not compare favourably with dry separation of the same material.

Tabling of the magnetic product from N6 revealed the presence of significant amounts of free tin, apparently coated with iron oxide like slime. The result of the tabling is as follows:

Product	*% Mass*	*% Sn*	*% Sn Distn*
C	14.2	37.8	53.8
M	13.5	11.7	15.8
T	72.3	4.2	30.4
Composite M/A	100.0	10.0	100.0

Group 2, Tests N7 to N13 - Rougher separations

Fixed conditions

Plates:	Salient pole as in Group 1.
Plate gap:	Reduced to 3 mm.
Wash water:	As in Group 1 (18 *l*/min).
Pulse:	As in Group 1 (400 kPa).
Feed rate:	Reduced to 1.4 kg/min.
Feed dilution:	Reduced to 10% solids.
Field current:	10 to 40 A range over six tests.

Results

Product	*% Mass*	*% Sn*	*% Sn Distn*
N7 10 A			
M/A	16.6	5.0	9.0
M	27.7	14.3	15.4
N	55.7	20.9	75.6
Composite Head	100.0	15.4	100.0
N8 15 A			
M/A	34.0	5.5	11.0
M	12.5	14.8	10.9
N	53.5	24.9	78.1
Composite Head	100.0	17.0	100.0
N9 20 A			
M/A	47.2	5.9	16.1
M	13.6	11.9	9.4
N	39.2	32.9	74.5
Composite Head	100.0	17.3	100.0
N10 25 A			
M/A	55.4	6.7	21.4
M	10.0	15.0	8.6
N	34.6	35.2	70.0
Composite Head	100.0	17.4	100.0
N11 30 A			
M/A	54.3	7.5	23.8
M	16.5	12.9	12.4
N	29.2	37.4	63.8
Composite Head	100.0	17.1	100.0

	Product	% Mass	% Sn	% Sn Distn
N12 35 A				
	M/A	54.4	6.5	23.8
	M	15.6	15.6	11.5
	N	30.0	32.1	64.1
	Composite Head	100.0	14.9	100.0
N13 40 A				
	M/A	55.1	7.1	23.9
	M	15.6	10.9	10.3
	N	29.3	36.8	65.8
	Composite Head	100.0	16.4	100.0

Comment

Dilution of feed and reduction of feed and plate gap have resulted in a marked increase in the amount of magnetics rejected compared with the tests in Group 1. Tin losses in the magnetics have also increased (up to double in the high amperage tests). However the efficiency of the separation in Group 2 appears to be better as mass rejection in the magnetics increases more steeply than tin rejection. The tin content of the washings is relatively constant throughout the range of tests.

Under the conditions of the this group of tests no particular advantage was gained by increasing field current beyond 25 A.

There is a significant increase in the grade of the non-magnetic product compared with Group 1 Series.

Visual examination of magnetics indicated the presence of free tin as confirmed by the previously mentioned tabling test.

Comparison with the dry magnetic separation was not favourable.

Group 3, Tests N15, N16 and N17 - Cleaner separation of magnetics obtained from tests in Group 2.

N15 relates to the primary separations of tests N7, N8 and N9 and is not reported as the primary separations were not satisfactory.

N16 is based on cleaner separations of the rougher magnetics obtained from Tests N10 and N11. Test conditions were as in N7 and N13, with a field current of 30 A.

Results

Product	*% Mass*	*% Sn*	*% Sn Distn*
Rougher sep. M/S 1 (Average N10, N11) N + M	45.1	29.6	77.4
Cleaner sep. N16 M/S2			
N	11.7	17.6	10.2
M	8.1	6.8	2.7
M/A	35.1	5.6	9.7
Composite M/S1 M/A	54.9	7.1	22.6
Composite Head	100.0	17.2	100.0

Comment

Cleaner magnetic separation has resulted in the recovery in the cleaner non-magnetics of a further 10% of the total tin at a grade of 17.6% Sn.

The overall result shows a recovery of 88.6% at a grade of 28.8% Sn.

Weight rejection of magnetics of 35.1% is disappointingly low when compared to the dry separator results.

The result of Test N17, based on cleaner separation of magnetics from N12 and N13 was similar to the above and is not reported.

Group 4, Tests N18 and N19

Recleaner separation of cleaner magnetics obtained from tests in Group 3.

N18 after attrition scrubbing for 30 minutes at 70% solids.
N19 after Batch ball mill grind 5 minutes at 70% solids.

Both tests were deslimed before magnetic separation.

Since the feed for these two tests was derived from all tests in Group 3 which in turn emanated from all tests in Group 2 it is not sensible to give a precise tabulation of the result.

In general, however both tests indicate that about 30% of the tin in the secondary magnetics can be recovered. (An additional 3% recovery overall at a grade of about 14% Sn). This boosts overall recovery to about 90% at an average grade of approximately 28% Sn.

Group 5, Tests N20, N21, N22 and N23.

Rougher and cleaner magnetic separation after:

N20 and N22: 30 minutes attrition, 70% solids.
N21 and N23: 6 minutes ball mill grind, 70% solids.

Feed deslimed before rougher separation.

Conditions

Rougher separation: As in Group 2.
Cleaner separation: As in Group 2, except that feed dilution reduced to 5% solids and feed rate to 0.7 kg/min.

Result

Product	*% Mass*	*% Sn*	*% Sn Distn*
Rougher M/S1 N	28.3	38.7	61.4
(N20) M	15.1	15.0	12.6
M/A	46.1	8.8	22.8
Slime Decant.	10.5	5.5	3.2
Composite Head	100.0	17.9	100.0
Cleaner M/S2 N	6.0	29.7	10.0
(N22) M	8.1	5.2	2.3
M/A	32.0	5.8	10.5
Consolidated result			
Tin product M/S1 N & M plus M/S2 N	39.4	30.2	84.0

Tests N21 and N23 gave similar results apart from a slightly higher loss in the slime decant and the details are not reported.

Comment

Rougher and cleaner separation of attritioned separator feed has given an overall recovery of 84% at an average grade of 30.2% Sn. This result is practically the same as that obtained in Tests N10, N11 (Rougher) and N16 (Cleaner) in Group 3.

(c) GRAVITY CONCENTRATION IN CONJUNCTION WITH HIGH INTENSITY WET MAGNETIC SEPARATION, TO PRODUCE SALE GRADE TIN CONCENTRATE.

N1 - Tabling followed by magnetic separation.

Approximately 5½ kg of the crude concentrate was tabled with retreatment of coarse tailings and middlings. The table concentrate was then submitted to Jones high intensity wet magnetic separation, with cleaning of rougher magnetics.

Result

Product	*% Mass*	*% Sn*	*% Sn Distn*
TC M/S1 N + M) M/S2 N)	24.0	58.0	72.7
M/S2 M	2.7	27.6	2.9
M/S2 M/A	25.5	10.7	14.2
TT	47.8	4.1	10.2
Composite Head	100.0	19.2	100.0

N2 - Magnetic separation followed by tabling of non-magnetic.

Approximately 3½ kg of the crude concentrate was submitted to cleaner magnetics separation followed by table concentration of rougher and cleaner non-magnetics and rougher washings. Retreatment of coarse tailing and middling was included in the tabling operation.

Result

Product			*% Mass*	*% Sn*	*% Sn Distn*
M/S1 N + M) TC			26.6	53.6	77.5
M/S2	N)				
M/S2	M		13.0	10.4	7.4
M/S2	M/A		42.2	5.7	13.2
	TT		18.2	1.9	1.9
Composite Head			100.0	18.4	100.0

Magnetic separator conditions

Field current: 35 A
Wash water (machine stationary in wash position) 9 *l*/min.
Pulse: 260 kPa

Other conditions generally as for tests in Group 3.

Comment

A better recovery was obtained by employing magnetic separation ahead of tabling. N2 shows about a 5% increase in recovery although concentrate grade dips from 58% to 53.6% Sn. There is also a shift in tin loss from table tailings in N1 to cleaner magnetic washings (M) in N2. It would be reasonable to class this as a middling product whose retreatment would further enhance recovery.

The results of both tests would be improved by classification ahead of tabling.

SUMMARY

The tests have shown that high intensity wet magnetic separation has a useful application in removing magnetic material from Razorback crude concentrate.

The most critical factors affecting performance are feed rate, feed dilution and field current.

Low feed rates at dilutions of not more than 10 per cent solids appear to be necessary.

Little advantage is to be gained by increasing field current beyond 25 A at the plate gap in Group 2 tests (3 mm).

Examination of magnetic products indicates the presence of apparently magnetic cassiterite. This may be caused by iron oxide slimes coating the grains. However, attrition scrubbing or ball mill grinding did not give any apparent improvement in this condition.

The efficiency of wet magnetic separation does not compare favourably with that of dry separation. However an overall assessment should consider the physical advantages of an on stream wet separator as against the question of drying and feeding of crude concentrate to a dry separator. Overall recoveries in finished concentrates would probably not be very different.

[18 June 1975]