TR 10_123_131

R. 496 - R. 499

CONSOLIDATED GOLD FIELDS—RENISON LTD: MAGNETIC SEPARATION TESTS ON MILL PRODUCTS

Sample

Four samples of mill products were submitted by the above company for magnetic separation tests on a Gill type high intensity wet magnetic separator.

The samples were described as follow:

R. 496. Mill Flotation Feed.
R. 497. Gravity Feed.
R. 498. Tub Toppings.
R. 499. Final Concentration.

The Gill Magnetic Separator

The following description of the machine has been supplied by Mr. B. W. Stratford of H. T. Reading Ltd., Lismore, N.S.W., who are its manufacturers.

Mr. Stratford assisted with some aspects of the test work, particularly in the operation of the separator.

THE GILL TYPE HIGH INTENSITY WET MAGNETIC SEPARATOR
4 POLE PROTOTYPE MODEL

An induced Rotor type electromagnetic separator for the extraction of magnetic particles from a pulp.

Introduction

This machine consists of a Rotor having a vertical shaft which is arranged to rotate between four alternative magnetic poles. These poles are secured to an external yoke which forms part of the magnetic circuit. North and South poles are arranged alternately thus providing a "Null Point" midway between poles. The general arrangement is similar to the field and armature assembly of a D.C. electric motor.

Rotor

This is constructed of material of high permeability with low carbon content. This is in the form of a truncated cone of acute angle having an O.D. of 12" at the top, and 13" at the bottom. Two hundred teeth are machined on the outside circumference of the rotor at an included helicar angle of 10° to the vertical shaft. These teeth act as concentration points for the magnetic flux.

Poles

These consist of a soft iron core around which is fitted an electro magnet coil. The faces of these poles are machined to suit curvature of the Rotor and provide the necessary air gap. Stainless steel shoes are attached to the faces of the poles to prevent magnetic particles from adhering to the faces and also to direct the pulp and wash water by means of riffles which are incorporated on these shoes.

Operation

The pulp is introduced into the leading edge of the air gap between each pole and rotor. In this position the rotor teeth become induced poles of high magnetic intensity and the magnetic particles are attracted while the non-magnetic particles pass through. Wash water is administered to the pulp whilst still under the poles to minimize entrainment. As the rotor rotates the magnetic particles are conveyed beyond the influence of the poles to a "Null Point" where, due to change of polarity they can be washed off with a jet of water and collected in a launder which is directly below.

The field strength of this machine is variable by means of a single phase variac in a range of 4,750 to 13,250 gauss.

The rotor speed is variable in the range of 5 to 15 r.p.m.

INVESTIGATION

The object of the investigation was to demonstrate the performance of the Gill separator in the treatment of the above mill products, primarily with regard to the elimination of pyrrhotite, which is the major sulphide mineral in the Renison Bell mine ore.

Currently the magnetic pyrrhotite and other sulphides amounting to as much as 70 per cent of the ore are rejected by froth flotation. Reagents used are sulphuric acid, copper sulphate, xanthates and M.I.B.C.

The air gap between pole faces and rotor of the machine was set at 0.075 inches, and was not varied throughout the entire programme of tests. Decrease of this gap may have a significant influence on the performance of the machine in the removal of minerals of lower magnetic susceptibility such as the iron carbonate mineral encountered in the tub toppings and possibly the final concentrate. Adjustable air gap is to be provided in future units.

*R.*496. *Mill Flotation Feed*

Several rougher type exploratory tests were performed with various field strengths, rotor speeds and feed rates to establish conditions which appeared to give reasonable results. These were followed by cleaner separation tests, the products from which were examined in more detail.

Examination of these products included sizing analyses and tin and sulphur distribution in the various fractions.

A similar sizing analysis was made of the head sample.

A test involving rejection of sulphides by cleaner flotation was also performed, and the results of this test are included for comparative purposes.

*R.*497. *Gravity Feed*

One test was performed on this sample because of the small quantity submitted. Cleaner magnetic separation produced three fractions which were examined for tin and sulphur content and distribution. The head sample and non-magnetic fractions were also sized plus and minus 100 mesh B.S.S. to give information with regard to the size range of the eliminated sulphides.

R. 498. *Tub Toppings*

One test under rougher conditions was performed. Products were examined for tin, sulphur, and carbon dioxide to indicate the degree of elimination of pyrrhotite and pistomestite.

R. 499. *Final Concentrate*

One test only under rougher conditions was undertaken to indicate whether any substantial upgrading of the concentrate could be obtained by magnetic separation. The head sample and the two products were sized plus and minus 100 mesh B.S.S. to show the size ranges of the eliminated sulphides.

R.496. MILL FLOTATION FEED

Assays

Tin 2.04 percent
Sulphur 27.7 percent.

	Test Conditions						
Test No.	2 Ro	4 Ro	6 Ro	7 Ro	7 Cl	9 Ro	9 Cl
Field: Amps	11.6	7.6	3	4	4	10	10
Rotor Speed: r.p.m.	13	9	15	12	12	12	12
Feed Rate: lb./hr.	450	370	800	480	400	350	300
Wash Water: gal./min./pole.	1.5	3	3	3	3	3	3
Scour Water: gal./min./pole.	1.5	1.5	1.5	1.5	1.5	1.5	1.5

Test Results

Test No. and Product	*Per Cent*			*Per Cent Distribution*	
	Weight	*Tin*	*Sulphur*	*Tin*	*Sulphur*
2. Magnetics	71.2	0.56		19.4	
Non-Magnetics	28.8	5.74		80.6	
Composites	100.0	2.05		100.0	
4. Magnetics	74.5	0.61	33.7	23.0	89.9
Non-Magnetics	25.5	5.97	11.1	77.0	10.1
Composites	100.0	1.98	27.9	100.0	100.0
6. Magnetics	64.5	0.43		13.9	
Non-Magnetics	35.5	4.86		86.1	
Composites	100.0	1.99		100.0	
7. Cl Magnetics	60.1	0.34	35.1	9.4	78.4
Cl Non-Magnetics	4.7	2.06	26.0	4.4	4.5
Ro Non-Magnetics	35.2	5.35	13.1	86.2	17.1
Composites	100.0	2.18	26.9	100.0	100.0
9. Cl Magnetics	69.6	0.47	35.0	15.2	86.6
Cl Non-Magnetics	5.0	3.82	18.3	8.9	3.3
Ro Non-Magnetics	25.4	6.41	11.2	75.9	10.1
Composites	100.0	2.15	28.1	100.0	100.0

Rejection of Sulphides of Cleaner Flotation

A cleaner flotation test in a 10 kg Agitair cell was undertaken on the sample for comparative purposes. Reagents used were sulphuric acid, copper sulphate, ethyl and amyl xanthates, and M.I.B.C.

Test No. and Product	*Per Cent*			*Per Cent Distribution*	
	Weight	*Tin*	*Sulphur*	*Tin*	*Sulphur*
R.496-10					
Cl Sulphide Float	80.95	0.48	34.0	18.9	97.2
Cl Sink	4.60	6.86	6.28	15.4	1.0
Rougher Sink	14.45	9.35	3.49	65.7	1.8
Composite	100.0	2.06	28.3	100.0	100.0

Sizings

R. 496. *Mill Flotation Feed. Head Sample*

Fractions (Equivalent Cassiterite particle diameter microns.)	*Per Cent*			*Per Cent Distribution*	
	Weight	*Tin*	*Sulphur*	*Tin*	*Sulphur*
+ 60	1.29	0.55	8.29	0.4	0.4
+ 72	1.08	0.62	16.4	0.3	0.7
+ 85	3.15	0.61	22.9	0.9	2.6
+100	3.65	0.62	27.4	1.1	3.6
+120	6.66	0.71	28.7	2.3	6.9
+150	8.76	0.88	29.7	3.8	9.4
+170	7.58	1.40	30.4	5.2	8.3
+200	5.77	1.76	30.6	5.0	6.4
C.S. 1. −76+23	10.57	6.12	32.9	31.6	12.5
2. −23+17	11.87	2.98	31.1	17.3	13.3
3. −17+12	13.46	2.04	28.8	13.4	14.0
4. −12+8	6.75	1.71	26.7	5.6	6.5
5. − 8+6	3.48	1.46	27.4	2.5	3.4
−5. − 6	(15.93)	(1.36)	(20.9)	10.6	12.0
Composite	100.00	2.04	27.7	100.0	100.0

R.496/7. *Cleaner Magnetics from Mill Flotation Feed*

Fraction	Per Cent			Per Cent Distribution	
	Weight	*Tin*	*Sulphur*	*Tin*	*Sulphur*
+ 85	3.64	0.49	31.6	4.8	3.2
+100	4.57	0.48	35.4	5.9	4.5
+150	18.59	0.45	35.9	22.4	18.7
+200	16.20	0.48	36.3	20.8	16.5
C.S. 1.	15.18	0.77	37.3	31.3	15.9
2.	14.79	0.25	35.9	9.9	14.9
3.	15.58	0.09	35.0	3.8	15.3
4.	4.77	0.05	34.3	0.6	4.6
5.	1.91	0.03	32.2	0.2	1.7
−5	(4.77)	(0.02)	(35.1)	0.3	4.7
Composite	100.00	0.37	35.7	100.0	100.0

R.496/7. *Cleaner Non-Magnetics from Mill Flotation Feed*

Fraction	Per Cent			Per Cent Distribution	
	Weight	*Tin*	*Sulphur*	*Tin*	*Sulphur*
+ 85	1.98	0.64	8.35	0.7	0.6
+100	1.08	0.70	14.7	0.4	0.6
+150	6.81	0.97	23.8	3.4	6.1
+200	6.99	2.05	27.1	7.4	7.1
C.S. 1.	7.87	9.72	27.0	39.4	8.0
2.	14.06	3.25	26.5	23.5	14.0
3.	20.79	1.46	26.8	15.6	20.8
4.	13.18	0.65	28.6	4.4	14.1
5.	6.54	0.48	29.0	1.6	7.1
−5	(20.70)	(0.34)	(27.9)	3.6	21.6
Composite	100.00	1.94	26.7	100.0	100.0

R.496/7. *Rougher Non-Magnetics from Mill Flotation Feed*

Fraction	Per Cent			Per Cent Distribution	
	Weight	*Tin*	*Sulphur*	*Tin*	*Sulphur*
+ 85	7.47	0.73	1.84	1.0	1.1
+100	3.78	1.33	5.01	1.0	1.5
+150	11.11	2.57	8.37	5.5	7.5
+200	8.71	5.31	10.4	8.8	7.3
C.S. 1.	6.78	28.3	15.1	36.6	8.3
2.	13.38	8.77	11.9	22.4	12.9
3.	9.91	5.28	12.8	10.0	10.2
4.	8.52	3.47	14.7	5.6	10.1
5.	4.87	2.48	16.7	2.3	6.6
−5	(25.47)	(1.41)	(16.8)	6.8	34.5
Composite	100.00	5.24	12.38	100.0	100.0

Note—All sizings of minus 200 mesh material were performed in a Warman Cyclosizer and the equivalent ranges of cassiterite particle diameter are shown for each fraction. Figures shown in brackets are derived values. All screens used were B.S.S.

SUMMARY: R.496. MILL FLOTATION FEED

1. Results indicate that the bulk of the sulphides can be removed by cleaner magnetic separation without excessive loss of tin in the magnetic fraction.

The quantity of sulphur remaining in the non-magnetic fractions ranges from 11 to 13 per cent.

2. Comparison of rejection of sulphides by flotation is seen in the results shown below.

	Method		
		Magnetic	
Sulphide Reject	*Flotation*	*Test 7*	*Test 9*
Weight, per cent	80.95	60.1	69.6
Tin, per cent	0.48	0.34	0.47
Tin, per cent distribution	18.9	9.4	15.2
Sulphur, per cent	34.0	35.1	35.0
Sulphur Per Cent			
In Flotation Sinks	4.2		
In Non-Magnetics		14.6	12.3

The percentage of sulphur rejected by flotation amounted to 97 per cent, and by cleaner magnetic separation this rejection amounted to 78 and 86 per cent.

The sulphur content of the gravity feed after magnetic separation is higher than that obtained by current flotation rejection.

However, the sulphide content may be low enough to produce low grade primary concentrates, and the residual sulphides removed in secondary treatment. Alternatively the magnetic separation process could be considered as a primary treatment to remove pyrrhotite, followed by flotation rejection of other sulphides.

Based on the sample examined 60 per cent of the ore could be rejected to waste by magnetic separation, and a further 20 per cent by flotation. Some reduction in the cost of reagents could be anticipated.

3. The sizing analyses of the products from Test 7 show that almost all coarse sulphides (plus 200 mesh) have been removed in the magnetic fraction. This could possibly have some benefit to subsequent flotation, as these coarse sulphides are probably the least amenable to flotation.

4. The low tin contents of the finer sizes of the cleaner magnetics together with optimum sulphur assays show that practically no mechanical entrainment of non-magnetics takes place.

It can be assumed, therefore, that the tin reporting in the coarser sizes of the magnetics is present as composite particles, and that these losses are unavoidable without finer grinding to release composites.

R.497. MILL GRAVITY FEED

Assays

Tin 5.46 per cent.
Sulphur 2.79 per cent.

Test Conditions

	Rougher	Cleaner
Field: Amps	4	4
Rotor Speed: r.p.m.	10	10
Feed Rate: lbs. solids/hr./pole.	222	....
Wash Water: gal./min./pole.	3	3
Scour Water: gal./min./pole	1.5	1.5

Separation performed using only one pole of the Gill Separator.

Test Results

Test No. 4 Product	*Per Cent*			*Per Cent Distribution*	
	Weight	*Tin*	*Sulphur*	*Tin*	*Sulphur*
R.497. Cl Magnetics	6.7	1.84	19.1	2.2	47.4
Cl Non-Magnetics	1.4	5.64	1.79	1.4	0.9
Ro Non-Magnetics	91.9	5.74	1.52	96.4	51.7
Composite	100.0	5.48	2.70	100.0	100.0

Sizings

Product and Screen Sizes	*Per Cent*		*Sulphur Per Cent Distribution*	
	Weight	*Sulphur*	*Individual*	*O'all*
R.497. Head +100	18.9	3.65	25.6	25.6
−100	81.1	2.48	74.4	74.4
Composite Head	100.0	2.70	100.0	100.0
Ro Non-Mag. +100	17.7	0.84	11.4	5.9
−100	82.3	1.41	88.6	45.8
Composite Ro Non-Magnetic	100.0	1.31	100.0	51.7
Cl Non-Mag. +100	11.6	2.06	14.7	0.1
−100	88.4	1.57	85.3	0.8
Composite Cl Non-Magnetic	100.0	1.63	100.0	0.9
Cl Magnetics +100	By difference			19.6
−100				27.8
Composite Cl Magnetic				47.4

SUMMARY: R.497. MILL GRAVITY FEED

1. The test shows that approximately half the sulphur content of this mill product can be eliminated by cleaner magnetic separation. The tin in the magnetic fraction is quite minor, amounting to only 2.2 per cent.

2. Sizing of the products shows that most of the coarse sulphide (plus 100 mesh) has been discarded in the magnetic fraction. Apart from this no significant benefit appears to have been gained by magnetic separation.

R.498. TUB TOPPING

Assays:

Tin 25.0 per cent.
Sulphur 2.53 per cent.

Test Conditions

Field: Amps	11.6
Rotor Speed r.p.m.	9.5
Feed Rate: lbs./hr./pole.	46
Wash Water: gal./min./pole.	3
Scour Water: gal./min./pole.	1½

Separation using one pole of the Gill Separator, rougher only.

Test Results

Test No. and Product	Per Cent				Per Cent Distribution		
	Weight	Tin	Sulphur	Carbon Dioxide	Tin	Sulphur	Carbon Dioxide
R.498. Magnetics	27.0	6.60	2.78	29.4	7.1	32.6	46.9
Non-Magnetic	73.0	31.8	2.13	12.3	92.9	67.4	53.1
Composite	100.0	25.0	2.31	16.9	100.0	100.0	....

SUMMARY. R.498. TUB TOPPING

This test, at maximum field strength, shows a rejection in the magnetics of less than half (46.9 per cent) of the carbonate mineral present. The magnetics contain 7.1 per cent of the total tin.

The non-magnetics assay 31.8 per cent tin, an increase of only 6.8 per cent over the feed value.

However, a decrease in the air gap between the pole faces and rotor of the Gill Separator may increase the proportion of magnetics, with a consequent increase in the tin value of the non-magnetics. At this stage, the investigation has not been extended to cover this variation in conditions.

R.499 FINAL CONCENTRATE

Assays

Tin 64.1 per cent.
Sulphur 2.45 per cent.

Test Conditions

Field: Amps	11.6
Rotor Speed: r.p.m.	7
Feed Rate: lbs. solids/hr./pole	132
Wash Water: gal./min./pole	3
Scour Water: gal./min./pole.	1½

Separation using one pole of the Gill Separator, rougher test only.

Test Results

Test No. and Product	*Per Cent*			*Per Cent Distribution*	
	Weight	*Tin*	*Sulphur*	*Tin*	*Sulphur*
R.499. Magnetics	7.4	18.6	9.06	2.1	29.5
Non-Magnetics	92.6	67.9	1.73	97.9	70.5
Composite	100.0	64.3	2.27	100.0	100.0

Sizings of Products

Product and Screen Size	*Per Cent*		*Sulphur Per Cent Distribution*	
	Weight	*Sulphur*	*Individual*	*O'all*
R.499. Magnetics +100	16.9	26.1	49.9	14.7
Magnetics −100	83.1	5.34	50.1	14.8
Composite Magnetics	100.0	8.84	100.0	29.5
R.499. Non-Magnetics +100	0.6	5.59	1.7	1.2
Non-Magnetics −100	99.4	1.94	98.3	69.3
Composite Non-Magnetics	100.0	1.96	100.0	70.5
R.499. Head +100 / Head −100	Sum of magnetics and non-magnetics		15.9 / 84.1	15.9 / 84.1
R.499. Composite Head			100.0	100.0

SUMMARY: R.499. FINAL CONCENTRATE

Magnetic separation has removed practically all coarse sulphides from this product with a loss of 2.1 per cent of the tin. However, no substantial upgrading of the concentrate has been achieved.