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South Australia.

-RESEARCH AND DEVELOPMENT BRANCH-

METALLURGICAL SECTION.

FLOTATION TESTS ON PYRITIC ORE FROM NAIRNE, SOUTH AUSTRALIA.

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Copy No. 3.
This document consists of 15 pages.

DATE: May, 1956.

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-Contents-

FLOTATION TESTS ON PYRITIC ORE FROM NAIRNE, SOUTH AUSTRALIA.

by

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-Abstract-

This report gives details of laboratory scale batch flotation tests carried out on pyritic ore supplied by Nairne Pyrites Ltd. The work was carried out at Nairne, the object being to check the effect on flotation efficiency of variations in reagent amounts.

1. Summary.

Six series of flotation tests were carried out at Nairne on behalf of Nairne Pyrites Limited. Various factors influencing metallurgical efficiency were examined with the object of determining the optimum flotation conditions.

Different frother type reagents were tested and the results indicate that all were of equal effectiveness. Tests also revealed that when copper sulphate is used as an activating agent it should be allowed a short conditioning time prior to the introduction of the other reagents. Within limits, the amounts of copper sulphate, butyl xanthate and flotation oil "Timbrol 66" are not critical although in the case of Timbrol 66 the effect of small amounts may have been masked by the presence of other reagents in the circuit water.

The tests carried out on mill tailing material show that prolonged flotation should result in increased metallurgical efficiency.

2. Introduction.

A request was made to the South Australian Department of Mines for the services of an officer of the Department to carry out, under the direction of Nairne Pyrites Limited, a programme of flotation tests to determine the optimum amounts of flotation reagents required for efficient operation of

the concentration plant at Nairne.

The tests were carried out over two short periods, namely the

27th to the 30th of September and
the 5th to 7th of October, 1955 inclusive.

3. Material Tested.

Two samples of rod mill feed taken from the conveyor belt feeding the rod mill were ground to 100 per cent minus 10 mesh. The first sample was used as feed material for the flotation tests in series 1 to series 4 inclusive, while the second sample was used for series 6.

For series 5 flotation tests, final tailing from banks 1 and 2 of the roughing flotation cells was used as feed material.

The flotation reagents tested were:

Secondary butyl xanthate.
Copper sulphate.
Cresylic acid T.D.
Flotation oil "Timbrol 66".

4. Equipment used.

The main equipment used for the test work consisted of:

(a) Laboratory 500 gram batch ball mill.
(b) Laboratory 500 gram batch Fagergren flotation machine.

5. Experimental Procedure.

For series 1,2,3,4, and 6 the following standard procedure was employed.

For each test a 500 gram charge was used. This charge was ground in the ball mill at 60 per cent solids for a fixed time, estimated to give a ball mill discharge product containing approximately 50 per cent of minus 200 mesh material.

After grinding, the material was transfered to the bowl of the flotation machine, reagents added, and flotation carried out under the conditions indicated in section 6.

For series 5, where mill flotation tailing material was used as feed, a measured volume of pulp was taken and flotation carried out without any prior grinding,

The products from each test were filtered, oven dried, and assayed for sulphur content.

In all tests mill circuit water was used for grinding and flotation.

6. Conditions and Results.

6.1 Screen Analyses of feed material.

The two samples of ball mill feed gave the screen analyses shown in Table 1 after grinding for 10 and 11 minutes respectively. Sample 1 was used for series 1 to series 4 inclusive and sample 2 for series 6.

TABLE 1.

Ball Mill Discharge Material.

Mesh (Tyler)	Sample 1.		Sample 2.	
	% Wt.	Cum % Wt.	% Wt.	Cum % Wt.
+ 10	-	-	-	-
- 10 + 20	0.1	0.1	0.1	0.1
- 20 + 35	1.1	1.2	1.9	2.0
- 35 + 65	12.3	13.5	15.4	17.4
- 65 +150	26.0	39.5	24.8	42.2
-150 +200	10.2	49.7	8.0	50.2
-200	50.3	100.0	49.8	100.0
FEED	100.0		100.0	

As can be seen from Table 1 the fineness of grind of both samples is similar.

6.2 Series 1-Variation in type of frother.

The test conditions for this series are shown in Table 2, and the results shown separately in Table 3.

TABLE 2.

Test Conditions for series 1.

Test	$CuSO_4$		Butyl Xanthate		Cresylic Acid		Cresylic + T66⁎		T66+		Flotation Time (mins)
	lb/ton	Cond± (mins)	lb/ton	Cond (mins)	lb/ton	Cond (mins)	lb/ton	Cond (mins)	lb/ton	Cond (mins)	
1.1	0.5	4	$^{+}_{-}$0.17 0.08	- -	$^{+}_{-}$0.375 0.125	- -	- -	- -	- -	- -	3)8 5)
1.2	0.5	4	0.17 $^{+}_{-}$0.08	- -	- -	- -	0.375 $^{+}_{-}$0.125	- -	- -	- -	3) 5)8
1.3	0.5	4	0.17 $^{+}_{-}$0.08	- -	- -	- -	- -	- -	0.375 $^{+}_{-}$0.125	- -	3) 5)8

± Conditioning time (minutes).

\+ T66 is "Timbrol Flotation Oil 66".

⁎ Cresylic Acid + Timbrol 66 mixture was prepared using equal proportions of each.

Very little difference was observed in test 1.1, 1.2 and 1.3. The float for the first 30 seconds was brassy, becoming black after one minute and almost completely barren after five minutes. A good froth persisted for the whole eight minutes.

TABLE 3.

Results of Series 1.

Test	Fraction	% Weight	% Sulphur	% Distrib. Sulphur
1.1	Rougher Concentrate	31.7	30.3	92.3
	Rougher Tailing	68.3	1.16	7.7
	FEED	100.0	10.4	100.0
1.2	Rougher Concentrate	31.1	29.9	92.0
	Rougher Tailing	68.9	1.17	8.0
	FEED	100.0	10.1	100.0
1.3	Rougher Concentrate	32.7	29.0	92.1
	Rougher Tailing	67.3	1.19	7.9
	FEED	100.0	10.3	100.0

The results show no important difference in the effectiveness of the three frothers tested.

6.3 Series 2, Variation in Conditioning Time of Copper Sulphate.

The conditions and results of series 2 are shown in Tables 4 and 5 respectively. Observations made on each test are given with the conditions in Table 4.

TABLE 4.

Series 2 - Conditions and Observations.

Test	$CuSO_4$		Butyl Xanthate		T66		Remark.
	lb/ton	Cond. Mins.	lb/ton	Cond. Mins.	lb/ton	Cond. Mins.	
2.1	0.5	-	0.25	-	0.5	-	Dirty prolonged flotation. No brassy float. Not barren after 8 minutes.
2.2	0.5	2	0.25	-	0.5	-	Much bet er than 2.1 Brassy float. Barren after 4 mins.
[illegible]	0.5	4	0.25	-	0.5	-	Good float and froth. Barren after 4 mins.
2.4	0.5	6	0.25	-	0.5	-	Same as 2.3 Barren after 3-4 mins.
2.5	0.5	8	0.25	-	0.5	-	Same as 2.4
2.6	0.5	10	0.25	-	0.5	-	Same as 2.5
2.7	0.5	10±	0.25	-	0.5	-	More brittle froth although float same as 2.5
2.8	0.5	4	0.25	2	0.5	-	Good float and froth. Even flotation. Barren after 3 minutes.

Flotation time was 8 minutes for all tests.

± $CuSO_4$ added to ball mill prior to grinding.

TABLE 5.

Results of Series 2.

Test	Fraction	% Weight	% Sulphur	% Distrib. Sulphur
2.1	Rougher Concentrate	28.5	31.9	90.2
	Rougher Tailing	71.5	1.36	9.8
	FEED	100.0	10.1	100.0
2.2	Rougher Concentrate	31.6	28.4	91.8
	Rougher Tailing	68.4	1.17	8.2
	FEED	100.0	9.8	100.0
2.3	Rougher Concentrate	32.3	27.2	91.8
	Rougher Tailing	67.7	1.15	8.2
	FEED	100.0	9.6	100.0
2.4	Rougher Concentrate	36.4	26.8	92.8
	Rougher Tailing	63.6	1.17	7.2
	FEED	100.0	10.5	100.0
2.5	Rougher Concentrate	29.6	30.5	91.8
	Rougher Tailing	70.4	1.16	8.2
	FEED	100.0	9.9	100.0
2.6	Rougher Concentrate	30.8	30.0	92.2
	Rougher Tailing	69.2	1.13	7.8
	FEED	100.0	10.0	100.0
2.7	Rougher Concentrate	28.6	31.2	90.1
	Rougher Tailing	71.4	1.37	9.9
	FEED	100.0	9.9	100.0
2.8	Rougher Concentrate	34.2	27.6	93.2
	Rougher Tailing	65.8	1.03	6.8
	FEED	100.0	10.1	100.0

The difference between the tailing sulphur assay of tests 2.1 and 2.2 to 2.6 indicate that some conditioning of the $CuSO_4$ prior to flotation is beneficial. Addition of $CuSO_4$ to the ball mill prior to grinding however, does not appear to be effective.

6.4 Series 3- Variation in Amount of Copper Sulphate.

The conditions together with observations, and results from series 3 are shown in Tables 6 and 7 respectively.

TABLE 6.

Series 3 Conditions and observations.

Test	$CuSO_4$		Butyl Xanthate		T66		Remarks.
	lb/ton	Cond. Mins.	lb/ton	Cond Mins	lb/ton	Cond. Mins.	
2.3+	0.5	4	0.25	-	0.5	-	Good float and froth. Barren after 4 minutes.
3.1	0.25	4	0.25	-	0.5	-	No apparent difference to 2.3
3.2	0.125	4	0.25	-	0.5	-	Same as 3.1

Flotation time was 8 minutes for all tests
+ Test 2.3 included for comparison.

TABLE 7.

Results of Series 3.

Test	Fraction	% Weight	% Sulphur	% Distrib. Sulphur.
2.3	Rougher concentrate	32.3	27.2	91.8
	Rougher tailing	67.7	1.15	8.2
	FEED	100.0	9.6	100.0
3.1	Rougher concentrate	34.6	26.8	92.7
	Rougher tailing	65.4	1.11	7.3
	FEED	100.0	10.0	100.0
3.2	Rougher concentrate	35.7	26.0	93.2
	Rougher tailing	64.3	1.06	6.8
	FEED	100.0	10.0	100.0

It appears that the amount of $CuSO_4$ required is not critical and may in fact be quite low.

6.5 Series 4 - Variation in Amount of "Timbrol 66".

The conditions together with observations and results are shown in Tables 8 and 9 respectively.

TABLE 8.

Series 4 - Conditions and Observations.

Test							Remarks.
	lb/ton	Cond. Mins.	lb/ton	Cond. Mins.	lb/ton	Cond. Mins.	
2.3+	0.5	4	0.25	-	0.5	-	Good float, and froth. Barren after 4 minutes.
4.1	0.5	4	0.25	-	0.3	-	Same as 2.3
4.2	0.5	4	0.25	-	0.2	-	Same as 2.3
4.3	0.5	4	0.25	-	0.1	-	Froth a little less stable for first minute. Otherwise same as 2.3

Flotation time was 8 minutes for all tests
+ Test 2.3 included for comparison.

TABLE 9.

Test	Fraction	% Weight	% Sulphur	% Distrib. Sulphur.
2.3	Rougher concentrate	32.3	27.2	91.8
	Rougher tailing	67.7	1.15	8.2
	FEED	100.0	9.6	100.0
4.1	Rougher concentrate	32.1	26.5	92.1
	Rougher tailing	67.9	1.05	7.9
	FEED	100.0	9.2	100.0
4.2	Rougher concentrate	35.7	25.2	93.2
	Rougher tailing	64.3	1.05	6.8
	FEED	100.0	9.7	100.0
4.3	Rougher concentrate	35.9	25.0	93.0
	Rougher tailing	64.1	1.05	7.0
	FEED	100.0	9.6	100.0

6.6 Series 5 - Plant Control Tests on Tailing Material.

In addition to the four series already outlined, a fifth series was carried out in which rougher tailing material from rougher cell banks 1 and 2 was used as flotation feed.

Tests 5.1 to 5.4 were carried out when the reagents being added to the cells were:

0.5 lb/ton $CuSO_4$
0.25 " Butyl Xanthate.
0.5 " T66.

Tests 5.1 and 5.2 were done on rougher bank 1 tailing material.
Tests 5.3 " 5.4 " " " " " 2 " "
(Samples for test 5.1 to 5.4 taken at 2.30 p.m. on 29/9/55).

Tests 5.5 to 5.8 were carried out when the reagents being added to the cells were:

0.5 lb/ton $CuSO_4$
0.31 " Butyl Xanthate.
0.50 " T66.

and air supercharging on Bank 1 was in operation.
Tests 5.5 and 5.6 were done on rougher bank 1 tailing material.
Tests 5.7 " 5.8 " " " " " 2 " "
(Samples for tests 5.5 to 5.8 were taken 9.30 a.m. on 30/9/55).

In tests 5.6 and 5.8 the tailing was floated for two minutes and rougher concentrate 1 taken off. The tailing from this flotation step was then reground in the ball mill for four minutes and refloated for two minutes with extra butyl xanthate to produce rougher concentrate 2.

All other conditions for tests 5.1 to 5.8 are given in Table 10, while the results are shown in Table 11.

TABLE 10.

Series 5 - Conditions and Observations.

Test	Butyl Xanthate		Flotation Time (mins)	Remarks.
	lb/ton	Cond. Mins.		
5.1	-	-	2	Good froth. Black in colour. Still black after 2 mins.
5.2	0.05	-	2	Much the same as 5.1 although more brassy froth. Still black after 2 minutes.
5.3	-	-	2	Same as 5.1
5.4	0.05	-	2	Same as 5.2
5.5	-	-	2	Good froth, with only a little black material floating. Barren after 2 minutes.
5.6#	0.05	2	2 (R.C. 1) 2 (R.C. 2)	Similar to 5.5 Regrind + Xanthate did not float much.
5.7	-	-	2	Same as 5.5
5.8±	0.05	2	2 (R.C. 1) 2 (R.C. 2)	Same as 5.6

± First laboratory flotation tailing reground for 5 minutes.
Xanthate added after this grinding stage.

TABLE 11.

Results of Series 5.

Test	Fraction	% Weight	% Sulphur	% Distrib. Sulphur
5.1	Rougher Concentrate	7.7	7.34	25.9
	Rougher Tailing	92.3	1.77	74.1
	FEED	100.0	2.20	100.0
5.2	Rougher Concentrate	7.0	8.24	27.4
	Rougher Tailing	93.0	1.66	72.6
	FEED	100.0	2.12	100.0
5.3	Rougher Concentrate	4.3	9.57	21.4
	Rougher Tailing	95.7	1.58	78.6
	FEED	100.0	1.92	100.0
5.4	Rougher Concentrate	6.3	7.57	25.1
	Rougher Tailing	93.7	1.53	74.9
	FEED	100.0	1.91	100.0
5.5	Rougher Concentrate	10.4	6.79	32.0
	Rougher Tailing	89.6	1.68	68.0
	FEED	100.0	2.22	100.0
5.6	Rougher Concentrate 1.	7.7	5.66	18.7
	Rougher " 2.	12.8	5.22	28.5
	Rougher Tailing	80.5	1.54	52.8
	FEED	100.0	2.35	100.0
5.7	Rougher Concentrate	8.0	6.40	24.2
	Rougher Tailing	92.0	1.74	75.8
	FEED	100.0	2.11	100.0
5.8	Rougher Concentrate 1.	6.1	7.75	22.9
	Rougher " 2.	6.6	4.82	15.6
	Rougher Tailing	87.3	1.44	61.5
	FEED	100.0	2.05	100.0

These results indicate that the sulphur grade of the mill tailing can be reduced by prolonging the flotation time and/or more effective flotation.

6.7 Series 6 - Variation in Amount of Butyl Xanthate.

The conditions and results of this series are shown in Tables 12 and 13 respectively.

TABLE 12.

Series 6 - Conditions and Observations.

Test	$CuSO_4$		Butyl Xanthate		T66		Remarks.
	lb/ton	Cond. Mins.	lb/ton	Cond. Mins.	lb/ton	Cond. Mins.	
6.1	-	-	-	-	-	-	Good froth, black, not much floating. Barren after 2 mins.
6.2	0.125	4	-	-	0.1	-	Similar to 6.1 Barren after 3 minutes.
6.3	0.125	4	0.05	2	0.1		Good froth, brassy in colour Barren after 3 minutes.
6.4	0.125	4	0.10	2	0.1	-	Same as 6.3 Appeared to be more material floating.
6.5	0.125	4	0.15	2	0.1	-	Same as 6.4
6.6	0.125	4	0.25	2	0.1	-	Same as 6.4
6.7	0.125	4	0.25	-	0.1	-	Slightly slower floating, other wise same as 6.4

Flotation time was 8 minutes in all tests.

TABLE 13.

Results of Series 6.

Test	Fraction	% Weight	% Sulphur	% Distrib. Sulphur
6.1	Rougher Concentrate	19.9	17.1	43.1
	Rougher Tailing	80.1	5.61	56.9
	FEED	100.0	7.9	100.0
6.2	Rougher Concentrate	24.0	15.6	43.5
	Rougher Tailing	76.0	5.23	56.5
	FEED	100.0	7.7	100.0
6.3	Rougher Concentrate	33.4	22.2	88.2
	Rougher Tailing	66.6	1.49	11.8
	FEED	100.0	8.4	100.0
6.4	Rougher Concentrate	33.8	21.6	88.6
	Rougher Tailing	66.2	1.41	11.4
	FEED	100.0	8.2	100.0
6.5	Rougher Concentrate	34.5	20.7	88.2
	Rougher Tailing	65.5	1.46	11.8
	FEED	100.0	8.1	100.0
6.6	Rougher Concentrate	37.2	20.1	89.7
	Rougher Tailing	62.8	1.35	10.3
	FEED	100.0	8.3	100.0
6.7	Rougher Concentrate	35.6	20.7	89.3
	Rougher Tailing	64.4	1.34	10.7
	FEED	100.0	8.2	100.0

These results indicate that above 0.05 lb/ton of Butyl Xanthate, no significant increase in sulphur recovery is obtained.

7. Discussion.

The results of series 1 to series 4 indicate that:

1. Flotation oil "Timbrol 66" is as effective as either cresylic acid or cresylic acid T66 mixture.

No difference in frothing characteristics was observed although the high concentration of reagent in the

circuit water may have masked any difference.

2. The conditioning time of $CuSO_4$ is not critical providing at least two minutes conditioning is employed. Conditioning in the ball mill during grinding was detrimental.

3. The addition of butyl xanthate should be followed by a short conditioning period, say at least two minutes.

4. The amount of $CuSO_4$ is not critical. An amount of 0.125 lb/ton gave results slightly better than those obtained using 0.5 lb/ton.

5. The amount of frother is not critical. An amount of 0.1 lb/ton gave results as good as those obtained from 0.5 lb/ton.
(Here again the reagent present in the circuit water may have masked the results).

6. Above 0.05 lb/ton of Butyl Xanthate, the amount of this reagent is not critical, an increase of only one per cent in sulphur recovery being obtained when using 0.25 lb/ton of Butyl Xanthate.

7. Series 5 indicated that either longer flotation time or more intense and effective flotation is required. On mill tailing samples a further two minutes flotation time appreciably reduced the sulphur content of the tailing.