RB 35/21

SOUTH AUSTRALIA

DEPARTMENT OF MINES

METALLURGICAL REPORT

No. 45

RECOVERY OF COPPER FROM MOONTA DUMPS

By
C. KNEEBONE
ASSISTANT METALLURGICAL ENGINEER

February, 1953

RECOVERY OF COPPER FROM MOONTA DUMPS

The ore submitted for beneficiation consisted of borehole samples from the Handcock tailings dump at the old treatment plant at Moonta.

Some 21 boreholes were systematically sunk in this dump by the Mines Department during 1951 to investigate the possibility of copper extraction in view of the acute shortage of this metal in Australia.

Sampling of the tailings dumps at Moonta indicates that the ore in the various dumps is generally similar in type but the Handcock dump is slightly higher in copper content.

GENERAL

Methods of beneficiation consisted of gravity, flotation and leaching tests. The average assay of the dump is approximately 0.26 per cent copper, of which o.02 per cent is oxidized, so a high recovery and relatively simple treatment is essential for the economic working of this dump.

The results outlined below, were obtained from the sample of ore submitted to us for testing.

Sizings are expressed in terms of British Standard Screens.

PRELIMINARY EXAMINATION

The ore requires very light crushing to free the particles as some are lightly cemented. A sample, when sized after crushing, gave the following results.

TABLE No 1

Mesh	%Weight	Copper		Distribution % Cu.
		Total	Oxidized	
+8	21.1	0.31	0.01	25.5
+10	6.9	0.22	0.01	6.0
+14	12.7	0.17	0.01	8.5
+22	14.1	0.15	0.01	8.3
+44	13.8	0.16	0.02	8.6
+60	8.7	0.21	0.02	7.2
+100	5.1	0.27	0.01	5.4
+150	3.2	0.32	0.02	4.6
+200	1.5	0.44	Tr.	2.6
-200	12.9	0.46	0.07	23.3
	100	0.26	0.02	100

Samples of the +8 mesh and + 60 mesh material were examined by the Petrologist, who reported as follows:-

"Any copper in the samples appears to be in the form of chalcopyrite, and also probably as oxidized weathered material not recognizable in poloshed section. The greater part of the chalcopyrite in the -44/+60 mesh sample is liberated as free material hence frinding to this stage appears to be desirable whereas in the case of the+8 mesh sample, the heavy fraction was comprised of composite grains which when ground up for briquetting showed adequate liberation of chalcopyrite".

GRAVITY CONCENTRATION

From Table No 1 approximately 64 per cent of the copper is contained in material at a size too coarse for flotation without grinding i.e. +60 mesh material.

Gravity concentration tests were run in an attempt to remove a low grade copper concentrate and eliminate coarse barren material before grinding.

A sample was screenee in to three fractions. +5mesh -5/+14 mesh and - 14 mesh.

The -5/+14 mesh material was treated on a Denver Pulsator Jig and the -14 mesh material passed over a Wilfley Table with the following results :

TABLE No 2

Combined Jig & Table Test

Product		% Weight	% Copper	% Distribution	%Distribution
+ 5 mesh material		6.8	0.37	12.0	---
Jig	Hutch	1.7	0.39	3.4	8.3
	Bed	9.4	0.23	10.6	25.9
+5/-14	Tailing	30.9	0.18	26.9	65.8
	Feed	42.0	0.19	40.9	100.0
Table	Concentrates	12.2	0.24	13.9	29.5
	Middling	5.5	0.16	4.3	9.1
-14/+60	Tailing	33.5	0.18	28.9	61.4
	Feed	51.2	0.19 *	47.1	100.0
Combine Feed		100.0	0,20*	100.0	

* Calculated

In neither case do results indicate that any recovery can be expected on coarsely crushed material.

A Wilfley Table test was then carried out on crushed - 60 mesh material with the following results:

TABLE No 2.
Table Test of - 60 mesh Feed

Product	%Weight	%Copper	%Distribution
Concentrate	1.7	0.81	7.1
Middlings	7.9	0.33	13.4
Tailings	90.4	0.17	79.5
Feed	100.0	0.19	100.0

In this test an attempt was made to produce a relatively high grade product with high recovery. Results were far from encouraging and tests were than confined to flotation and leaching.

FLOTATION TESTS

Flotation tests were carried out in a Wagergren Cell using 500 gram charges and the following reagent combinations.

(a) Collectors developed for oxidized ores

(b) Conditioning pulp with sulphur dioxide prior to flotation.

(c) Sulphurdizing using sodium sulphide.

Methods (a) and (c) gave similar recoveries up to 60 per cent which is considered to be too low to warrant treatment. With method (b) recovery was as high as 80 per cent with a concentrate of 7.47 per cent copper. While this grade could be raised by further cleaning the cost of reagents and plant makes this type of beneficiation uneconomic owing to the low grade of copper in the feed.

Samples for each test were ground for varying periods of 30 minutes or more in the laboratory ball mill at 60per cent solids with tap water, prior to flotation.

Reagent Combination (a)

Test 1 16 lbs/ton sulphuric acid Conditioned for 5 minutes
2 lbs/ton copper sulphate " " "
1.5 lbs/ton sod. sec. butyl xanthate " " "
.125lbs/ton Terpineol frother " " "

Results were as follows:

Product	%Weight	%Copper	% Distribution
Concentrate	1.95	5.9	59.5
Tailings	98 .05	0.08	40.5
Feed	100 .00	0.19	100.00

Test 2 9 lbs/ton calcium hydroxide Conditioned for 5 min
1.5lbs/ton Sod sec. butyl xanthata " " "
.125 lbs/ton Terpineol frother " " "

Results were as follows:-

Product	%Weight	%Copper	%Distribution
Concentrates	5.4	2.1	54.3
Tailings	94.6	0.1	45.7
Feed	100.0	0.21	100.0

Test 3. 16 lbs/ton Sulphuric acid Conditioned for 5 minutes
2 lbs/ton Copper sulphate " " "
5.4 lbs/ton Aerofloat 25 " " "
.125 lbs/ton terpineol frother " " "

Plus an additional 5.4 lbs/ton Aeroflat at end of float

Results were as follows:

Product	%Weight	%Copper	%Distribution
Concentrates	3.08	3.7	51.6
Tailings	96.92	0.11	48.4
Feed	100.00	0.22	100.00

A screen analysis of this flotation tailing was as follows:

Mesh	%Weight	Cumulative %
+60	2.8	2.8
100	8.8	11.6
150	22.2	33.8
200	31.4	65.2
-200	34.8	100.0

The greater part of the chalcopyrite should be liberated at this sizing, yet the recoveries are only in the 50-60 per cent range.

Reagent Combination (b)

In the tests using sulphur dioxide in conditioning before flotation, the gas was generated from sodium sulphite and sulphuric acid in controlled quantities and admitted via the inlet cock. Sodium secondary butyl xanthate was used as collector.

Test 1. 10 lbs. ton Sodium sulphite and 7.8 lbs sulphuric acid gave SO_2 conditioning for 10 minutes $_pH$ = 5.2
1 lb/ton butyl xanthate Conditioned for 2 minutes
Turpineol frother " " " "
Results were as follows:-

Product	%Weight	%Copper	%Distribution
Concentrates	1.58	7.47	80.0
Tailings	98.42	0.03	20.0
Feed	100.00	0.15	100.0

Test 2. 40 lbs/ton Sodium sulphite
31 lbs/ton Sulphuric acid
and SO_2 conditioning for 10 minutes pH = 5.3
1 lb/ton xanthate conditinion for 2 minutes
Terpineol frother
Results were as follows:

Product	%Weight	%Copper	%Distrubution
Concentrates	1.80	6.82	80.8
Tailings	98.20	0.03	19.2
Feed	100.00	0.15	100.0

Double grinding did not affect results.

Increasing the amount of Sulphur dioxide fourfold gives approximately similar recovery and grade.

Thirty three per cent of the copper in the tails was still oxidized after SO_2 conditioning and could be classed as irrecoverable by sulphide flotation methods.

The tailings from flotation tests using SO_2 conditioning were passed over a Wilfley table in an attempt to concentrate this oxidized portion with the following results:-

Product	%Weight	%Copper	%Distribution
Concentrates	9.6	0.05	6.4
Middling	6.2	0.05	4.2
Tailing	84.2	0.08	89.4
Feed (calculated)	100.0	0.07 0.08	100.0

The aim of the above test was again high recovery, ignoring grade of concentrate. Results show that there is no concentration whatsoever and indicate that the oxidized copper is slimed and follows the table tailing,

Reagent Combination (c)

A straight sulphidizing treatment using sodium sulphide was tried but recoveries were only around 60 per cent.

Test 1 Charges of 500 gramms were ground and pulped with 6 lbs / ton of sulphuric acid. The pulp was agitated for 30 minutes and filtered. The ore was replaced and the pH adjusted to 6 using sodium carbonate. Sodium sulphide was then added and conditioned for 10 minutes.

Added 0.5 lbs ton Reagent R 310 with Terpineol used as a frother.

Results were as follows:-

GILBURN BRICK COMPANY BURNSIDE

FIG. 1. View of South-eastern portion of main clay-slate quarry. Excavation for building stone in foreground.

FIG 2. Looking west to clay-slate treatment plant and brick kiln. Open cut workings at middle left are in Pleistocene alluvial clay.

PLATE 1.

Product	%Weight	%Copper	%Distribution	Remark
Concentrate	3.54	2.63	61.6	11b/ton Na_2S
Tails	96.46	0.06	38.4	
Feed	100.00	0.15	100.0	
Concentrate	3.33	2.55	59.9	41b/ton Na_2S
Tails	96.67	0.06	40.1	
Feed	100.00	0.14	100.0	

The oxidized copper in the tails assayed 0.01 per cent.

As flotation results were not favourable for economic beneficiation, tests were then directed to leaching.

LEACHING.

A series of leaching tests were carried out with the following results:-

Test	Weight Sample	Leach Liquor	Leach period	Cu Recovered	% Recovery
1	500 gm	500 cc" 10% H_2SO_4 by wt.	4 hours	.166 gm	12.8
2	"	" 5% " " "	"	.140	10.8
3	"	" 2.5% " " "	"	.093	7.1
4	"	" 1% " " "	"	.075	5.8
5	"	" 1% " by vol.	1 day	.115	8.8
6	"	" " " "	2 days	.135	10.4
7	"	" " "	5 "	.155	11.9
8	"	" " " "	8 "	.175	13.5
9	"	" " " "	1 day*	.115	11.5
10	"	" " " "	5 " *	.10	7.7
11	"	150 cc" 10% H_2SO_4 by wt	4 hours	.025	1.9
12	"	" 20% " " "	"	.052	4.0
13	"	" 10% " "	24 "	.072	5.5
14	"	" 20% " "	"	.066	5.1
15	"	" 2% HNO_3 "	4 hours	.030	2.3
16	"	" 5% " "	"	.0395	3.0
17	"	" 5% HCl "	"	.044	3.4
18	"	" 10% " "	"	.045	3.5

* Sample agitated in Ball Mill. All other samples leached without agitation.

In view of the poor recoveries obtained no further work was undertaken but a sample of the dump material was chemically assayed for U_3O_8 and gave an assay of 0.04 lbs per ton. A bulk copper concentrate was produced and radiometrically assayed. This registered 13 counts per

minute and was recorded as assaying not greater than 0.05 lbs per ton. This is too low a grade for commercial purposes.

CONCLUSIONS

Tests show conclusively that the tailings are not amenable to gravity or leaching beneficiation, while the flotation tests show that this method would be uneconomic in view of the low copper content of the dump. Further experimental work on these dumps is not recommended.

C. KNEEBONE