

Part II:

Ore Dressing and Ceramics

Section 1: Ore Dressing Investigations

TR14-185-189

R.559. Cassiterite flotation of Aberfoyle slime table feed

A sample of slime table feed was obtained from Aberfoyle Tin N.L. for an attempt to concentrate the cassiterite by flotation.

SAMPLE

The sample was contained in a five gallon drum as a pulp. The pulp density of the sample was 32 per cent solids, and the sample contained approximately 4.5 kg of dry solids.

A head sample was taken from the well-mixed pulp and assayed as follows:

Sn	1.05%	sulphide S	1.95%
Pb	0.06%	WO ₃	0.47%
Cu	0.31%	CO ₂	3.7%
Zn	0.80%		

NOTE: (1) No responsibility will be accepted for the results shown in this report except in so far as they apply to the sample tested.

(2) Make-up water used in tests was Launceston town supply.

TEST WORK

Samples for testing were taken by removing a fixed volume from the well-mixed pulp to give an approximate dry weight of 400 g for each sample. All flotation tests were done with the Denver 'Sub.A' laboratory flotation machine model D-1 using the 250 g stainless steel tank.

In test N1, sulphide flotation with sodium ethyl xanthate and copper sulphate was followed by cassiterite flotation with Cyanamid reagent R710 as collector and sodium silicate as quartz and silicate depressant.

In tests N2, N3, N4, and N5 the flotation feed was deslimed by allowing the pulp in the flotation cell to settle for five minutes and then siphoning off the top inch of pulp. Sulphide flotation for 10 minutes followed using sodium ethyl xanthate and copper sulphate. In test N5, a stage addition of potassium isopropyl xanthate was added after five minutes flotation. Cassiterite flotation followed using sodium silicate and Cyanamid reagents R710 in tests N2 and N5 and R765 and R825 in tests N3 and N4 respectively.

In test N6, slime removal and sulphide flotation with copper sulphate and sodium ethyl xanthate was carried out as in the previous tests. Cassiterite flotation followed with sodium silicate and sodium silicofluoride as depressants and phenyl ethylene phosphonic acid as collector. The natural pH of the pulp was 7.2. After five minutes flotation 0.2 lb/ton of sulphuric acid was added which brought the pH down to 4.8. A further five minutes flotation followed at the lower pH.

In tests N7, N8 and N9 the slime was removed by passing the sample through a 30 mm glass cyclone with a gravity head of 15 ft.

In test N7, flotation was carried out without prior sulphide removal with soda ash and isohexyl phosphonic acid. The concentrate so formed was refloat with copper sulphate and sodium ethyl xanthate for sulphide removal.

Amyl xanthate and copper sulphate were used in test N8 for removal of sulphide. Cassiterite flotation was then carried out with sodium silicofluoride, sodium silicate, and sulphuric acid with a small addition of phosphonic acid as collector.

Test N9 was similar to test N8 except that the sulphuric acid addition was doubled to 0.2 lb/ton and the isohexyl phosphonic acid was increased ten fold to 5.0 lb/ton.

Details of the reagent additions and operating conditions are shown in Table 1.

Some trouble was experienced in floating all the sulphides prior to cassiterite flotation. Increased sodium ethyl xanthate additions, longer flotation time, a stage addition of potassium isopropyl xanthate, and comparatively large additions of potassium amyl xanthate failed to prevent the occurrence of sulphide in the subsequent cassiterite flotation.

A sample of the cassiterite flotation concentrate from test N9 assaying 1.72% Sn was examined mineragraphically and found to contain an estimated 40% of feldspar and quartz, 25% sulphides, 15% tourmaline, 10% carbonates, 5% zircon, and 3% muscovite and biotite.

A sample of the 30 mm desliming cyclone overflow from test N7 was sized in the cyclosizer with the following result:

Fraction	% Weight	% Weight cumulative
C.S.1	1.0	1.0
2	2.7	3.7
3	6.4	10.1
4	8.7	18.8
5	8.0	26.8
6	73.2	100.0

The results of test N1 in which flotation products were assayed for sulphide S, Sn, WO₃ and CO₂ are shown below:

Product	% Weight	Assay %			
		Sulphide S	Sn	WO ₃	CO ₂
FC1	19.5	7.90	1.02	0.21	1.6
FC2	11.9	3.48	0.78	0.19	2.3
FT	68.6	0.30	1.33	0.42	3.0
H	100.0	2.16	1.20	0.35	2.64

Product	Distribution %			
	Sulphide S	Sn	WO ₃	CO ₂
FC1	71.3	16.7	11.4	11.8
FC2	19.0	7.5	5.7	10.2
FT	9.7	75.8	82.9	78.0
H	100.0	100.0	100.0	100.0

The results of the remaining tests in which the flotation products were assayed for Sn only are shown in Table 2.

TABLE 1. REAGENT ADDITIONS AND OPERATING CONDITIONS

Reagent or condition	Unit	N1	N2	N3	N4	N5	N6	N7	N8	N9
Slime removal		none	siphon	siphon	siphon	siphon	siphon	cyclone	cyclone	cyclone
Copper sulphate	lb/ton	0.5	0.5	0.5	0.5	0.5	0.5	—	0.5	1.0
Conditioning time	min.	2	2	2	2	2	2	—	—	—
Sodium ethyl xanthate	lb/ton	0.1	0.2	0.2	0.2	0.2	0.1	—	—	—
Potassium amyl xanthate	lb/ton	—	—	—	—	—	—	—	0.2	0.5
Conditioning time	min.	—	2	2	2	2	—	—	2	2
Aerofroth 65	lb/ton	0.1	—	—	—	—	—	—	—	—
M.I.B.C.	lb/ton	—	0.05	0.05	0.05	0.05	0.05	—	0.05	0.05
Flotation time	min.	5	10	10	10	10	5	—	5	5
Potassium isopropyl xanthate after 5 min. flotation	lb/ton	—	—	—	—	0.2	—	—	—	—
Sodium silicofluoride	lb/ton	—	—	—	—	—	1.0	—	1.0	1.0
Sodium carbonate	lb/ton	—	—	—	—	—	—	2.0	—	—
Sulphuric acid	lb/ton	—	—	—	—	—	—	—	0.1	0.2
Conditioning time	min.	—	—	—	—	—	—	—	10	10
Sodium silicate	lb/ton	5.0	2.0	2.0	2.0	2.0	1.0	—	1.0	1.0
Conditioning time	min.	5	2	2	2	2	5	—	—	—
Cynamid R710	lb/ton	0.5	2.0	—	—	2.0	—	—	—	—
Cynamid R765	lb/ton	—	—	1.0	—	—	—	—	—	—
Cynamid R825	lb/ton	—	—	—	1.0	—	—	—	—	—
Phenyl ethylene phosphonic acid	lb/ton	—	—	—	—	—	0.5	—	—	—
Isohexyl phosphonic acid	lb/ton	—	—	—	—	—	—	0.5	0.5	5.0
Conditioning time	min.	2	2	2	2	2	—	5	5	10
pH (not measured unless stated)		—	—	—	—	—	7.2	—	—	—
Flotation time	min.	5	5	5	5	5	5	5	10	5
Sulphuric acid	lb/ton	—	—	—	—	—	0.2	—	—	—
Conditioning time	min.	—	—	—	—	—	5	—	—	—
pH (not measured unless stated)		—	—	—	—	—	4.8	—	—	—
Flotation time	min.	—	—	—	—	—	5	—	—	—
Rfloat—										
Copper sulphate	lb/ton	—	—	—	—	—	—	1.0	—	—
Sodium ethyl xanthate	lb/ton	—	—	—	—	—	—	0.5	—	—
Conditioning time	min.	—	—	—	—	—	—	2	—	—
Flotation time	min.	—	—	—	—	—	—	3	—	—

TABLE 2

Test	Product	% Weight	Assay % Sn	Sn distribution %
N2	Slime	15.7	1.11	15.3
	FC1	15.9	0.9	12.6
	FC2	26.8	1.69	40.6
	FT	41.6	0.84	31.5
	H	100.0	1.11	100.0
N3	Slime	17.2	1.11	16.5
	FC1	13.3	0.9	10.4
	FC2	14.5	1.17	14.8
	FT	55.0	1.22	58.3
	H	100.0	1.15	100.0
N4	Slime	18.3	1.20	20.2
	FC1	13.0	0.8	9.2
	FC2	16.1	0.88	12.8
	FT	52.6	1.20	57.8
	H	100.0	1.09	100.0
N5	Slime	20.8	1.19	21.6
	FC1	13.0	1.00	11.2
	FC2	29.7	1.53	38.8
	FT	36.5	0.91	28.4
	H	100.0	1.16	100.0
N6	Slime	12.0	1.26	12.3
	FC1	9.8	1.21	9.7
	FC2	11.4	3.13	29.0
	FC3	7.0	1.77	10.1
	FT	59.8	0.80	38.9
	H	100.0	1.23	100.0
N7	Slime	46.3	1.15	41.0
	F1T	45.7	1.50	52.8
	F2C	3.8	1.07	3.2
	F2T	4.2	0.93	3.0
	H	100.0	1.30	100.0
N8	Slime	22.4	1.08	19.1
	FC1	12.6	1.30	12.9
	FC2	10.6	1.04	8.7
	FT	54.4	1.38	59.3
	H	100.0	1.27	100.0
N9	Slime	22.2	1.16	21.3
	FC1	14.4	1.30	15.4
	FC2	34.6	1.72	49.0
	FT	28.8	0.60	14.3
	H	100.0	1.21	100.0

ABBREVIATIONS:

FC1	first flotation concentrate (sulphides)
FC2	second flotation concentrate (cassiterite)
FC3	third flotation concentrate (cassiterite)
FT	flotation tail
F1T	rougher flotation tail
F2C	re-flotation concentrate
F2T	re-flotation tail
H	head

CONCLUSIONS

This investigation was only of a preliminary nature due to the limited knowledge of cassiterite flotation and to the limited size of the sample. The response of cassiterite to flotation was generally poor throughout the series of tests.

Three collectors showed some promise and are worthy of further investigation: Cyanamid R710, phenyl ethylene phosphonic acid and isohexyl phosphonic acid.

In tests N2 and N5 using Cyanamid R710, recoveries and concentrate grades were 40.6% at 1.69% Sn and 38.8% at 1.53% Sn respectively.

In test N6 using 0.5 lb/ton of phenyl ethylene phosphonic acid, a recovery of 29.0% at 3.13% Sn was obtained at natural pH 7.2 with five minutes flotation. A further five minutes flotation at pH 4.8 yielded a further recovery of 10.1% at 1.77% Sn. Combining the two concentrates we have an overall recovery of 39.1% at 2.61% Sn. It is probable that a similar result would have been obtained without lowering the pH of the pulp and merely floating for the extra five minutes.

In test N9, 5.0 lb/ton of isohexyl phosphonic acid was used and resulted in a 49.0% recovery at 1.72% Sn concentrate grade.

Further research using the Box-Wilson method for systematic investigation would probably reveal conditions to give better response of cassiterite to flotation.