TR8-183-188

R. 426

HYDROCYCLONE TESTS ON MILL VANNER FEED

Sample

A sample of thickened pulp stated to be current mill vanner feed was received from the company in January, 1963. A sample of the pulp was sized by screening and infrasizing with the following results:—

Fraction	Theoretical Grain Size in Microns Cassiterite	Quartz	Percent Weight	Tin	Tin Distribution Percent	Percent Cum.
+100 ..	..	..	0.7			
+150 ..	..	..	1.8	0.7	0.4	0.4
+200 ..	..	..	5.2	0.63	0.7	1.1
I.S. 1. ..	+45	+56	1.4	13.09	4.0	5.1
2. ..	45–30	56–40	19.5	5.75	24.5	29.6
3. ..	30–20	40–28	11.5	6.93	17.4	47.0
4. ..	20–14	28–20	9.7	6.95	14.7	61.7
5. ..	14–10	20–14	8.5	6.22	11.6	73.3
6. ..	10– 8	14–10	7.5	5.28	8.7	82.0
7. ..	– 8	–10	34.2	2.40	18.0	100.0
Composite ..	..	..	100.0	4.57	100.0	..

A vanning assay on the head sample showed a value of 3.06 per cent tin which is equivalent to a recovery of 66.9 per cent.

The mean specific gravity of solids in the sample was determined as 3.2.

Investigation

The company requested hydrocyclone tests on the sample directed at producing a cyclone underflow suitable for table concentration, with a minimum amount finer than the tabling range.

The following information was supplied:—

Rate of production of proposed cyclone feed: 30 gallons/minute.

Pulp density of proposed cyclone feed: 8-10 per cent solids.

Suggested size of separation: 300-400 mesh cassiterite.

Previous investigations have shown that reasonably high recoveries may be expected from slime table concentration of cassiterite in the 20-30 micron range and coarser. In the course of the investigation, it was found that a separation at 400 mesh (about 40 micron) was not feasible under the conditions requested by the company, and discussion of test results has therefore been based on an attempted 20 micron separation.

The feed sizing analysis shows that 47 per cent of the tin is coarser than 20 microns.

Preliminary work on the samples showed that with spray underflow discharge, at least 70 per cent of the total solids reported in the cyclone underflow.

The overflow contained negligible coarse material, but there was a high proportion of fines in the underflow. The tests were therefore conducted under conditions of rope underflow discharge. For this reason and because of the dilute nature of the feed, and the inherent tendency of cassiterite to concentrate in the underflow, vortex finder diameter should be large in comparison with spigot diameter.

To reduce the amount of work involved, vortex finder diameter was standardized at $\frac{7}{8}$ inch, which is the largest available in the test unit. A feed inlet pressure of 40 psi which gives approximately the required throughput of 30 gallons/minute was used. Spigot openings only were varied to alter cyclone conditions.

Small spigot openings are the obvious choice, but the lower limit of opening is fixed by that below which the cyclone ceases to constantly operate. Even when this stage had been almost reached, there was still some 73 per cent of the total tin reporting in the underflow (Test 5). Such observations of underflow sizings from single stage tests were considered sufficient basis to carry out some tests on recycloning of the underflows in an attempt to reduce the quantity of fine cassiterite in the final underflow. These tests were performed at approximately 30 per cent solids feed density, which was chosen as being a reasonable figure and not necessarily that which favours the best separation.

The Test Unit

The test unit consists of a rubber lined 3 inch Warman hydraulic series "A" cyclone fed by a 1"/$\frac{3}{4}$" Warman split case pump fitted with a variable speed drive, range 500 rpm-2000 rpm. The cyclone is mounted over the pump sump and cyclone products can be returned to the sump, or withdrawn as required. The cyclone is supplied with vortex finders of $\frac{7}{8}$", $\frac{5}{8}$", and $\frac{3}{8}$" internal diameter, and a variety of spigots with bores ranging from $\frac{3}{4}$" down to 3/16" diameter.

The feed nozzle at the inlet to the periphery of the feed chamber is $\frac{1}{2}$" wide by $\frac{3}{4}$" deep, i.e. 0.375 square inches.

No responsibility is accepted for the results shown in this report, except in so far as they apply to the sample tested.

Summary

1. Single stage cycloning of the material at 10 per cent solids feed density only eliminated about half the minus 20 micron cassiterite from the cyclone underflow and is therefore of little use for the application under consideration.

This is illustrated by results of Test No. 5 which has the smallest spigot, ¼" in diameter, practicable with a ⅞" diameter vortex finder. The cyclone underflow contains 72.7 per cent of the total tin in the feed. Sizing analysis shows that 26.4 per cent of the tin in this product is finer than 20 microns. This amount is equivalent to approximately half the total minus 20 micron tin in the feed.

2. Single stage cycloning would be effective as a desliming operation before sizing in a unit such as a multi-spigot hydrosizer. Under the conditions of Test No. 2 a reasonably sharp separation is obtained at about 8 microns cassiterite particle diameter. The underflow contains 83.5 per cent of the total tin, and there is an almost negligible loss of recoverable tin in the overflow. Recycloning of the overflow would reduce this loss to virtually nil.

Since the slime overflow amounts to 39.6 per cent by weight, the amount of vanner feed would be materially reduced.

3. Recycloning of underflows from primary cycloning tests results in improved rejection of fines from the final underflow as is shown in Tests 5A and 5C.

Test 5A shows that the percentage of the total tin reporting in the underflow has been reduced to 45.2 per cent. Sizing analysis shows that 17.2 per cent of the tin in the product is finer than 20 microns, and amounts to some 17 per cent of the total minus 20 micron tin in the feed.

However, overall classification depreciates and there is an increase in the tin reporting in the coarser fractions of the overflow. In lieu of the installation of a more suitable sizing device, the two stage aspects of cyclone classification could be further studied, including variation of the feed density of the secondary cyclone.

Typical Test Results

Cycloning Conditions

Test No.	1 Prelimin-ary	2 Single Stage	5 Single Stage	5A Two Stage	5C Two Stage
Feed Inlet Pressure ..	40	40	40	35	30
Vortex Finder Diameter	5/8"	7/8"	7/8"	7/8"	7/8"
Spigot Diameter ..	5/16"	5/16"	1/4"	5/16"	1/2"
Type of Underflow ..	Spray	Rope	Rope	Rope	Rope tending to spray
Percent Solids—					
Feed	12	11	11	30 (approx)	30 (approx)
Overflow	4	5	6.5	20	14
Underflow	60	73.4	70	72	70
Distribution of Solids—					
Percent in: Overflow	29.9	39.6	60.5	81.4	73.4
Underflow	70.1	60.4	39.5	18.6	26.6
Distribution of Tin—					
Percent in: Overflow	..	16.5	27.3	54.8	39.3
Underflow	..	83.5	72.7	45.2	60.7

Sizing of Cyclone Products *Test No. 2: Single Stage*

Fraction	Percent (Overall Basis) Overflow Wt.	Wt. Cum.	Sn	Sn Dist.	Sn Dist. Cum.	Underflow Wt.	Wt. Cum.	Sn	Sn Dist.	Sn Dist. Cum.
+200 ..	..	..	..	..	..	9.1	9.1	0.57	1.1	1.1
I.S. 1. ..	..	..	..	..	..	4.4	13.5	7.58	7.3	8.4
2. ..	..	..	..	..	..	16.7	30.2	6.12	22.4	30.8
3. ..	..	..	..	..	..	12.9	43.1	7.11	20.1	50.9
4. ..	0.7	0.7	2.73	0.4	0.4	9.3	52.4	7.41	15.1	66.0
5. ..	2.4	3.1	1.18	0.6	1.0	4.5	56.9	9.47	9.4	75.4
6. ..	6.3	9.4	1.24	1.7	2.7	1.5	58.4	16.88	5.6	81.0
7. ..	30.2	39.6	2.07	13.8	16.5	2.0	60.4	5.58	2.5	83.5
Composite	39.6	..	1.90	16.5	..	60.4	..	6.30	83.5	..

Test No. 5: Single Stage.

Fraction	Percent (Overall Basis) Overflow Wt.	Wt. Cum.	Sn	Sn Dist.	Sn Dist. Cum.	Underflow Wt.	Wt. Cum.	Sn	Sn Dist.	Sn Dist. Cum.
+200 ..	Trace	..	..	..	..	10.1	10.1	0.74	1.5	1.5
I.S. 1 ..	Trace	..	..	..	..	4.2	14.3	11.73	10.1	11.6
2. ..	0.5	0.5	1.74	0.2	0.2	13.3	27.6	8.82	24.1	35.7
3. ..	3.0	3.5	0.21	0.1	0.3	6.8	34.4	12.77	17.8	53.5
4. ..	6.6	10.1	1.20	1.6	1.9	2.7	37.1	19.73	10.9	64.4
5. ..	8.0	18.1	2.20	3.6	5.5	1.1	38.2	26.09	5.9	70.3
6. ..	7.9	26.0	3.70	6.0	11.5	0.6	38.8	14.83	1.8	72.1
7. ..	34.5	60.5	2.22	15.8	27.3	0.7	39.5	4.03	0.6	72.7
Composite	60.5	..	2.19	27.3	..	39.5	..	8.98	72.7	..

Test No. 5A: Recycloning Underflow from Tests

Fraction	Percent (Overall Basis)									
	Combined Overflow					Final Under flow				
	Wt.	Wt. Cum.	Sn	Sn Dist.	Sn Dist. Cum.	Wt.	Wt. Cum.	Sn	Sn Dist.	Sn Dist. Cum.
+200 ..	3.0	3.0	0.44	0.3	0.3	7.1	7.1	0.86	1.2	1.2
I.S. 1. ..	2.4	5.4	3.42	1.7	2.0	1.8	8.9	22.8	8.4	9.6
2. ..	8.2	13.6	4.85	8.2	10.2	5.6	14.5	14.0	16.1	25.7
3. ..	7.1	20.7	4.07	6.2	16.4	2.7	17.2	21.1	11.7	37.4
4. ..	8.4	29.1	4.20	7.2	23.6	0.9	18.1	28.8	5.3	42.7
5. ..	8.8	37.9	4.12	7.4	31.0	0.3	18.4	33.5	2.0	44.7
6. ..	8.3	46.2	4.33	7.4	38.4	0.2	18.6	11.1	0.5	45.2
7. ..	35.2	81.4	2.25	16.4	54.8	Trace	18.6	..	..	..
Composite	81.4	..	3.26	54.8	..	18.6	..	11.9	45.2	..

Test No. 5C: Recycloning Underflow from Tests 5.

Fraction	Percent (Overall Basis)									
	Combined Overflow					Final Underflow				
	Wt.	Wt. Cum.	Sn	Sn Dist.	Sn Dist. Cum.	Wt.	Wt. Cum.	Sn	Sn Dist.	Sn Dist. Cum.
+200 ..	0.7	0.7	0.16	Trace	..	8.2	8.2	0.61	1.1	1.1
I.S. 1. ..	0.5	1.2	0.79	Trace	..	4.0	12.2	10.4	9.1	10.2
2. ..	5.4	6.6	1.14	1.5	1.5	8.6	20.8	10.2	19.3	29.5
3. ..	6.3	12.9	1.97	2.7	4.2	3.8	24.6	20.7	17.3	46.8
4. ..	8.1	21.0	2.75	4.8	9.0	1.4	26.0	33.0	10.1	56.9
5. ..	8.7	29.7	3.54	6.5	15.5	0.4	26.4	37.0	3.2	60.1
6. ..	8.3	38.0	4.18	7.2	22.7	0.2	26.6	14.1	0.6	60.7
7. ..	35.4	73.4	2.27	16.6	39.3	Trace	26.6	..	..	60.7
Composite	73.4	..	2.55	39.3	..	26.6	..	10.4	60.7	..

Tests Nos. 5 *and* 5A.

Comparison of percentage tin distribution at individual sizings in cyclone products from one and two stage tests.

Size of Fraction	5. Single Stage Overflow	Underflow	Feed	5A. Two Stage Overflow	Underflow
+200	Trace	100	100	17.8	82.2
I.S. 1.	Trace	100	100	16.7	83.3
2.	0.8	99.2	100	33.6	66.4
3.	0.7	99.3	100	34.9	65.1
4.	12.9	87.1	100	57.6	42.4
5.	38.0	62.0	100	78.3	21.7
6.	76.7	23.3	100	94.2	5.8
7.	96.4	3.6	100	100.0	Trace