

TR6_223_228

R. 389

ELECTROLYTIC ZINC COMPANY OF AUSTRALASIA

CYCLONING LEAD CLEANER TAILINGS

The Sample

Two samples of thickened lead cleaner tailings were received from the Rosebery Mill of the Electrolytic Zinc Company of Australasia Ltd.

Each sample consisted of approximately eight gallons of pulp.

Sample R.389A was received 31st August, 1961.

Sample R.389B was received 7th November, 1961.

Sizings of the samples were—

Size Fraction	Sample R.389A Percent Weight	Sample R.389B Percent Weight
Plus 200 mesh	2.4	1.3
Plus I.S. 1	19.9	57.7
Plus I.S. 2	23.2	9.7
Plus I.S. 3	18.5	8.2
Minus I.S. 3	36.0	23.1
Composite	100.0	100.0

It will be noted that sample R.389B is much coarser than sample R.389A.

Investigation

The company requested a recommendation for a 6-inch Dorrclone installation to handle the plant lead cleaner tailings, and supplied the following information:—

Feed rate: 167 gallons of pulp per minute.

Pulp density: 28% solids: Further dilution not possible.

Specific gravity of solids: Approximately 4.5.

Classification split required: As sharp as possible at 19 microns (galena basis).

Pulp density of cyclone underflow: 70-72% solids, as suitable feed for regrind mill.

Regrind mill discharge is not to be returned to cyclone feed.

Feed inlet area of proposed cyclones (Dorrclones) is 1.23 square inches.

The infrasizer products are normally calibrated in equivalent quartz particle sizes. The table on the following page gives the equivalent quartz and galena particle sizes for the various fractions.

	Size: Microns	
	Quartz	Galena
200 mesh screen (B.S.)	+76	+76
I.S. Cone 1	+56	+33
I.S. Cone 2	+40	+24
I.S. Cone 3	+28	+17
Minus I.S. Cone 3	-28	-17

The required sizing split is at 19 microns, which does not correspond exactly with any infrasizer equivalent. The test work has been based on an equivalent 17 microns (galena basis) split, i.e. on the third cone products of the infrasizer.

Summary

Based on data from test work with a 3-inch Warman cyclone, the 167 gallons per minute of Rosebery lead cleaner tailings would be handled by either—

- (a) two (2) 6-inch Dorrclones at pressures of 40 pounds per square inch;
- (b) three (3) 6-inch Dorrclones at pressure of 25 pounds per square inch.

The second alternative is recommended. Initial cost of the installation will be higher, but pumping costs and wear on cyclone parts will be lower.

The Dorrclones should have the following dimensions—

Feed inlet area: 1.23 square inches.

Vortex finder diameter—1½ inches.

Spigot diameter—1-inch approximately.

The spigot diameter should be such that a comparatively small reduction will alter the spray underflow to a rope or semi-rope underflow.

Sizings of the cyclone products should be similar to those obtained in tests R.389A/15 or R.389/B9, depending on the nature of the feed.

The two samples received from Rosebery varied considerably in size distribution, and for this reason a number of tests have had to be discarded. Sizings of the two samples are quoted in the body of the report.

The Test Unit

The test unit consists of a rubber lined 3" Warman hydraulic series "A" cyclone fed by a 1" ³/₄" Warman split case pump. The cyclone is mounted over the pump sump and the cyclone products can be returned to the sump, or withdrawn as required. The pump is driven through a Charles and Hunting variable speed drive with output speed range of 500 r.p.m. to 2000 r.p.m. With normal operation, feed inlet pressures can be quickly and simply varied in the range zero to about 70 pounds per square inch by alteration of the pump speed.

The Warman cyclone is supplied with a set of three soft abrasion resistant rubber spigots having bores of $\frac{5}{16}$ ", $\frac{9}{16}$ " and $\frac{3}{4}$ " diameter. The cyclone is fitted with means for adjusting the spigot during operation, and a variety of spigot openings may be made below the limit of $\frac{3}{4}$ inches. However, due to the difficulty of accurately measuring the effective diameter of the distorted rubber spigots, fixed diameter spigots were made and used throughout the test work.

The cyclone is supplied with vortex finders of internal diameter $\frac{7}{8}$ ", $\frac{5}{8}$ " and $\frac{3}{8}$ ".

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

Research

The company's initial request was for a split at 28 microns (galena basis). Sizing of the first sample indicated that a split at 28 microns would require roughly a 50-50 split of the solids into the overflow and underflow. Preliminary cyclone tests showed that such splits could be attained only with rope discharge from the cyclone. With spray discharge and comparatively high cyclone pressures, at least 80% of the solids reports in the underflow, giving an overflow containing very little oversize, but the underflow contains a large proportion of the fines.

Cyclone tests were therefore directed at conditions of rope discharge and more particularly at conditions of transitional rope-spray discharge. As will be seen from the following table, with all other conditions remaining constant, a very small change in the orifice diameter will result in the change from spray to rope discharge with the attendant major change in the characteristics of the cyclone products (compare results of test R.389A/15 and R.389A/16).

Preliminary tests with different diameter vortex finders showed that similar splits were made with similar vortex finders/spigot orifice ratios within the limits of the vortex finders supplied with the cyclone. Accordingly the largest diameter ($\frac{7}{8}$ -inch) vortex finder was used throughout the test work to give maximum cyclone throughput.

The company later requested a split at approximately 19 microns (galena basis).

Test No.	Orifice Diameter (in)	Pressure (psi)	Flow Rate (gpm)	Split (%)
15	0.375	100	100	50-50
16	0.375	100	100	50-50
17	0.375	100	100	50-50
18	0.375	100	100	50-50
19	0.375	100	100	50-50
20	0.375	100	100	50-50
21	0.375	100	100	50-50
22	0.375	100	100	50-50
23	0.375	100	100	50-50
24	0.375	100	100	50-50
25	0.375	100	100	50-50
26	0.375	100	100	50-50
27	0.375	100	100	50-50
28	0.375	100	100	50-50
29	0.375	100	100	50-50
30	0.375	100	100	50-50
31	0.375	100	100	50-50
32	0.375	100	100	50-50
33	0.375	100	100	50-50
34	0.375	100	100	50-50
35	0.375	100	100	50-50
36	0.375	100	100	50-50
37	0.375	100	100	50-50
38	0.375	100	100	50-50
39	0.375	100	100	50-50
40	0.375	100	100	50-50

Typical Test Results: Sample R.389A

Test No.	R.389A/15	R.389A/16	R.389A/17	R.389A/18
Feed inlet pressure: p.s.i.	40	40	40	35
Vortex finder dia- meter: ins.	$\frac{7}{8}$	$\frac{7}{8}$	$\frac{7}{8}$	$\frac{7}{8}$
Spigot diameter: ins.	$\frac{9}{16}$	$\frac{1}{2}$	$\frac{7}{16}$	$\frac{3}{8}$
Type of underflow ..	Spray	Rope, tending to spray	Rope	Rope
Pulp density: per- cent solids—				
Feed	30	32	32	33
Overflow	7	17	17	20
Underflow	77	80	80	80
Recovery of solids: percent—				
In overflow ..	14.6	40.3	41	47
In underflow ...	85.4	59.7	59	53
Total volume passed by cyclone: gal- lons/min.	31	29	27	29

Sizing of Cyclone Underflow

Percent weight —

+ 200 mesh	2.3	4.0	5.5	3.6
+ I.S. 1	23.8	31.8	37.5	32.0
+ I.S. 2	26.6	35.6	32.0	35.0
+ I.S. 3	21.3	17.9	15.0	17.4
— I.S. 3	26.0	10.7	10.0	12.0
Composite ..	100.0	100.0	100.0	100.0

Sizing of Cyclone Overflow

Percent weight —

+ 200 mesh	Trace	Trace	Trace	Trace
+ I.S. 1	Trace	0.3	1.0	1.7
+ I.S. 2	Trace	5.0	11.6	10.4
+ I.S. 3	2.5	18.7	21.2	21.6
— I.S. 3	97.5	76.0	66.2	66.3
Composite	100.0	100.0	100.0	100.0

Test R.389A/15 (above) gives a separation reasonably close to that required.

The overflow contains only 2.5% by weight of plus 17 micron (galena basis) material. However, the underflow contains 26% by weight of minus 17 micron (galena basis) material, and this represents about 60% of the minus 17 micron (galena basis) material in the feed. The other tests R.389A/16-18 (above) give reduced quantities of minus 17 micron material in the underflow, but the quantity of plus 17 micron material in the overflow has risen appreciably.

Further series of tests at lower pressures were carried out on the second sample, R.389B. As mentioned earlier, this sample is much coarser than the original sample, R.389A. Due to this variation in sizing, it is difficult to compare results from the two samples. Typical results are given below.

Typical Test Results: Sample R.389B

Test No.	R.389B/9	R.389B/11
Feed inlet pressure: ... p.s.i.	25	10
Vortex finder diameter: ins.	$\frac{7}{8}$	$\frac{7}{8}$
Spigot diameter: ... ins.	9/16	$\frac{1}{2}$
Type of underflow	Spray	Semi-rope
Pulp density: percent solids—		
Feed	29	29
Overflow	9	18
Underflow	70	77
Recovery of solids: percent—		
In overflow	20.4	47.1
In underflow	79.6	52.9
Total volume passed by cyclone: ... gal./min.	22	13
Sizing of Cyclone Underflow		
Percent weight—		
+ 200 mesh	1.8	2.3
+ I.S. 1	72.0	84.7
+ I.S. 2	10.2	6.0
+ I.S. 3	8.0	3.5
— I.S. 3	8.0	3.5
Composite	100.0	100.0
Sizing of Cyclone Overflow		
Percent weight—		
+ 200 mesh	Nil	Trace
+ I.S. 1	0.8	27.5
+ I.S. 2	1.8	16.3
+ I.S. 3	4.8	15.0
— I.S. 3	92.6	41.2
Composite	100.0	100.0

Considering test R.389B/9, the cyclone underflow is a satisfactory product, both with regard to sizing and density. The overflow contains more coarse material than test R.389A/15 but this is probably due to the coarser feed, rather than to lower cyclone pressures.

Cyclone separation in test R.389B/11 was poor.

Discussion of Test Results

Based on test work with the 3" Warman cyclone, and conversion of these conditions to 6" Dorrclone operation gives:—

	3-inch Warman cyclone (actual)	6-inch Dorrclone (calculated)
Feed inlet pressure: ... p.s.i.	40	40
Feed inlet area: ... sq. ins.	0.375	1.23
Volume passed: ... gals/min.	31	102
Feed inlet pressure: ... p.s.i.	25	25
Feed inlet area: ... sq. in.	0.375	1.23
Volume passed: ... gals/min.	22	72

Total feed volume is 167 gallons per minute. Therefore the feed should be handled by two Dorrclones at a pressure slightly below 40 pounds per square inch.

Alternatively the feed would be handled by three Dorrclones at a pressure slightly below 25 pounds per square inch.

The Warman cyclone had the following dimensions in tests R.389A/15 and R.389B/9.

Feed inlet area:
0.375 sq. ins.

Vortex finder:
diameter $\frac{7}{8}$ inches.
c.s.a. 0.601 sq. ins.

Spigot:
diameter 9/16 inches.
c.s.a. 0.249 sq. ins.

Using these ratios, the Dorrclone dimensions become—

Feed inlet area:
1.23 sq. ins.

Vortex finder:
c.s.a. 1.97 sq. ins.
diameter 1.58 inches.
say $1\frac{1}{2}$ inches.

Spigot:
c.s.a. 0.82 sq. ins.
diameter 1.02 inches.
say 1-inch.

However, near the transition point, a very small change in the spigot diameter will alter the underflow from spray to rope. The 1-inch spigot diameter calculated above should therefore be regarded as indicative only. The orifice diameter should be determined by restricting the orifice to give a rope discharge, and then increasing the orifice until the underflow just changes to spray underflow.