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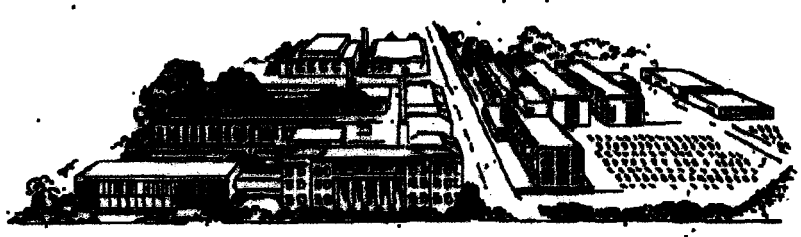
RESEARCH REPORT



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PHASE REPORT

on

PILOT-PLANT BENEFICIATION OF ITALIAN RUN-OF-MINE TALC

to

JOHNSON AND JOHNSON

March 8, 1960

by

R. W. Schatz

BATTELLE MEMORIAL INSTITUTE
505 King Avenue
Columbus 1, Ohio

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Battelle Memorial Institute

505 KING AVENUE COLUMBUS 1, OHIO

March 28, 1960

Mr. W. H. Ashton
Johnson and Johnson
Research Department
New Brunswick, New Jersey

Dear Mr. Ashton:

We are pleased to transmit six copies of our Phase Report, "Pilot-Plant Beneficiation of Italian Run-of-Mine Talc".

As pointed out in the report, the runs were quite successful in that a superior talc product of high luster and platiness was obtained at a high recovery.

Sincerely yours,

O. F. Tangel

O. F. Tangel

OFT/mln
Enc. (6)

cc: Dr. W. H. Lycan
Mr. C. V. Swank

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PHASE REPORT

on

PILOT-PLANT BENEFICIATION OF ITALIAN RUN-OF-MINE TALC

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INTRODUCTION AND SUMMARY

Laboratory work* had shown that a superior talc product could be produced by wet grinding and flotation of Italian run-of-mine** talc. Consequently, Italian run-of-mine talc was processed in the pilot plant to demonstrate the technical feasibility of the process and to obtain drum quantities for panel testing.

The treatment procedure was as follows: after hammermill crushing to minus 1/4 inch, the talc was ground wet in a pebble mill, in closed circuit with cyclones, to approximately 98 per cent minus 200 mesh. After removal of the major portion of the minus 10-micron fraction in other cyclones, the platy talc was recovered by flotation, filtered, and spray dried. Sixty to sixty-five per cent by weight of the feed to the plant was recovered as a superior talc product. Deionized water was used throughout the process.

The beneficiated talc was at least 99 per cent platy, analyzed from 0.2 to 0.3 per cent CO_2, contained about 12 to 13 per cent of minus 10-micron material, and had a luster higher than either the presently sold baby powder or the beneficiated Italian No. 2 talc.

* Progress Report, "The Physical Concentration of Talc Ores-Flotation of Italian Run-of-Mine Talc", December 31, 1959.
** Hereafter abbreviated as ROM.

SCOPE OF THE PILOT-PLANT WORK

The pilot-plant study of the beneficiation of Italian ROM talc was composed essentially of two phases. The first was to determine the operating conditions required in the grinding circuit to produce a suitable wet-ground talc for flotation. The second was to establish flotation conditions for the beneficiation of the wet-ground talc. The first phase was completed in the last half of September and the first half of October, 1959. The flotation phase was completed by the middle of November, 1959.

GRINDING INVESTIGATION

The grind desired on the Italian ROM talc was 98 per cent minus 200 mesh with a minimum of minus 10-micron material. Equipment in the crushing and grinding circuit included a hammermill (4)*, pebble mill (8), two cyclones (10, 10a) together with the necessary pumps (9, 9a), conveying (3-5), storage (6), and feeding (7) facilities. A feed rate of about 450 pounds per hour to the grinding circuit was desired because this rate was the approximate capacity of the beneficiation section of the pilot plant.

Crushing

The ROM talc was received in burlap sacks (150 pounds per sack) and had been crushed to about minus 2 inches. In order to maintain a fixed storage bin level, three sacks of talc were crushed per hour; two on the hour, one on the half hour. The hammermill product was nominally minus 1/4 inch in size. Table 1 presents typical screen analyses of the ROM talc before and after hammermill crushing.

Grinding

The following general plan was used to determine the operating conditions required for the desired grind. For each set of conditions the circuit was first operated for about 4 hours to establish equilibrium. After equilibrium had been reached, as determined by pulp density and volume measurements throughout the circuit, the required samples were taken over a period of 2 to 3 hours. Based on the analyses of these samples, changes were made in the operating conditions, and after equilibrium was reached, the circuit was again sampled. This procedure was repeated until the desired operating conditions were established.

* For equipment specifications see corresponding identification number in the Phase Report "Design and Construction of a Talc Flotation Pilot Plant", December 30, 1959.

The initial tests, started on September 18, 1959, were made using the pebble mill (8) with 1500 pounds of 1-1/4-inch porcelain balls and the 4-inch (No. 1) short cyclone (10). It was soon apparent that insufficient grinding was being obtained in the mill, and, therefore, the pebble load was increased to 2900 pounds. Additional runs were made using the one cyclone with various apex (discharge) openings, feed and overflow discharge pressures, and pulp densities. The finest grind reached was 90 per cent minus 200 mesh with about a 20 per cent minus 10 microns.

It appeared that, to reach the desired grind, it would be necessary to use No. 1 and No. 2 cyclones in series, i. e., the second cyclone retreating the overflow from the first, with the underflow from both cyclones returning to the pebble mill. After considerable experimentation with this circuit, operating conditions were established which gave a grind of 98 per cent minus 200 mesh with 25 to 30 per cent minus 10 microns. This grinding investigation was completed on October 15, 1959.

Figure 1 shows the flowsheet of the grinding circuit. Typical operating data, as well as an approximate water-solids balance also are shown.

Table 1 gives typical screen size analyses for the various points in the grinding circuit. Tables 2 and 3 present additional operating data: volumes, pump densities, water requirements, cyclone operating pressures, and efficiency calculations.

The circulating load and classification efficiencies of Table 3 are worthy of comment. The circulating load of 660 per cent is rather high for a conventional ball mill-cyclone circuit. In addition, the classification efficiency of 21 per cent (based on recovery of minus 200-mesh material fed to the cyclone circuit) is low.

At least two factors contribute to these conditions. One is the platy character of talc. As particle shape deviates from a sphere or cube, classification becomes more difficult, and in a one-pass operation more inefficient. In addition, a 98 per cent minus 200-mesh grind with less than 0.3 per cent on 100 mesh is a difficult grind to reach, particularly with a platy material. Excellent rejection of the plus 200-mesh fraction must be obtained, and this is only accomplished at the expense of recirculating a considerable quantity of finished (minus 200 mesh) product to the pebble mill. The efficiency of rejection of plus 200-mesh material was excellent: 99 per cent, as shown in Table 3.

Further experimentation with the grinding circuit might lead to a grind of 98 per cent minus 200 mesh with less than 25 to 30 per cent of 10-micron material, as well as lower circulating loads and improved efficiencies. For an investigation of this sort, 24-hour (continuous) operation would be necessary with minor changes in the circuit from time to time. This type of an investigation is one that is best made in an operating plant because the effect of each minor change will be small and a number of days of operation under each set of conditions are necessary to establish the effect of the change. It is Battelle's opinion that improvements in the grind can be made which will reduce the quantity of minus 10-micron talc.

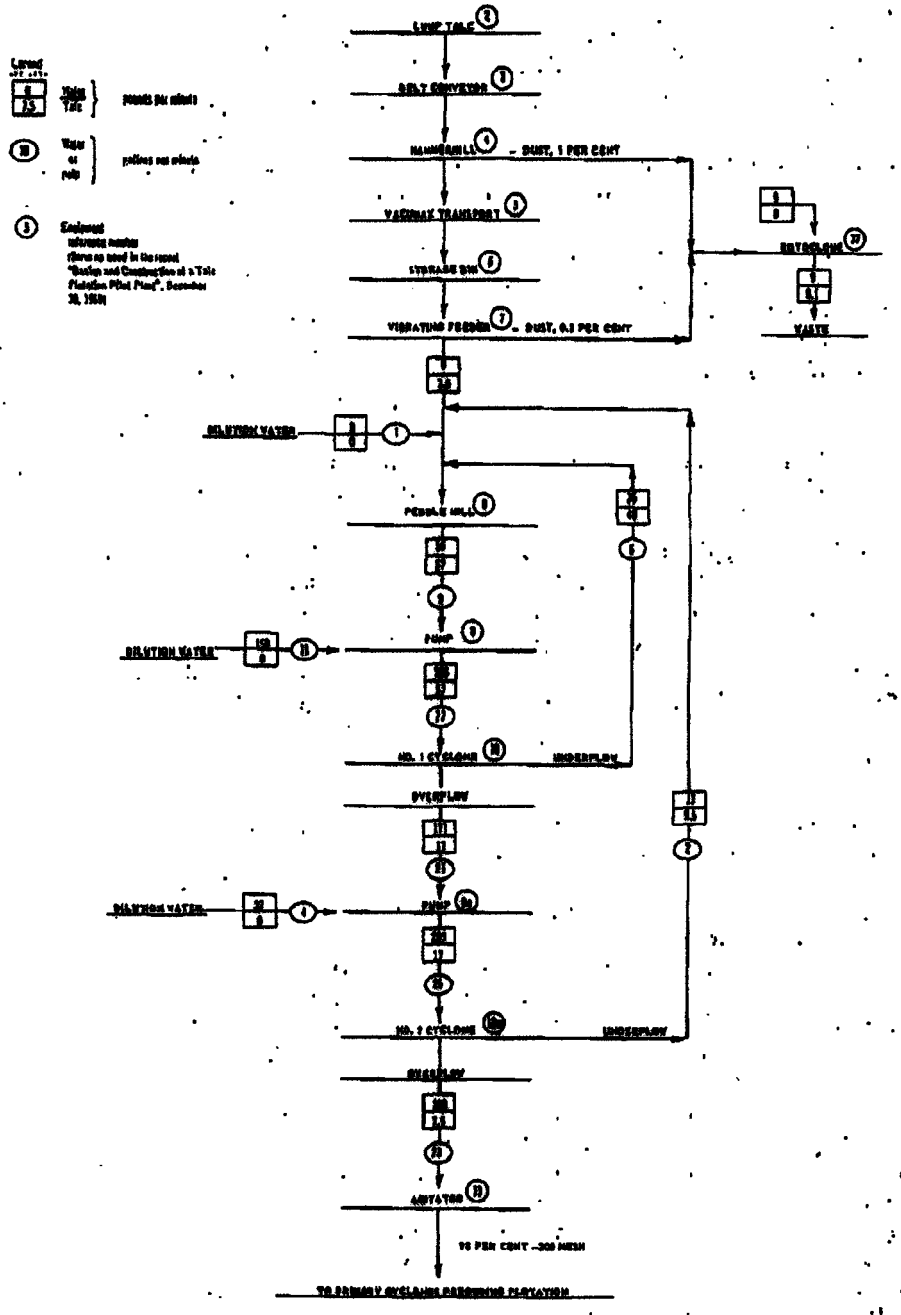

FIGURE 1. PILOT-PLANT GRINDING CIRCUIT FLOWSHEET FOR TREATMENT OF ITALIAN RUN-OF-MINE TALC

TABLE 1. TYPICAL SIZE-DISTRIBUTION DATA, CRUSHING AND GRINDING CIRCUIT[a]

Pilot-Plant Treatment of Italian Run-of-Mine Talc

	Size Distribution, per cent by weight						
	Hammermill		Ball-Mill	No. 1 Cyclone		No. 2 Cyclone	
Mesh	Feed[b]	Product[c]	Discharge	U'flow	O'flow	U'flow	O'flow[d]
+ 3	41.8	--	--	--	--	--	--
- 3+ 10	22.7	12.0	tr	tr	--	--	--
- 10+ 20	11.7	15.3	0.4	0.4	--	tr	--
- 20+ 35	5.8	17.3	1.7	2.5	--	tr	--
- 35+ 65	6.6	16.8	8.3	10.9	5.0	0.5	tr
- 65+100	2.9	6.5	14.5	16.3	3.2	3.2	tr
-100+200	3.2	6.1	14.2	14.5	2.2	10.4	2.0
-200	5.3	26.0	60.9	55.4	89.6	85.9	98.0
- 10 microns	0.3	1.0	6.8	--	--	--	29.6

(a) Run of October 22, 1959.
(b) All passing 2 inch.
(c) Ball-mill feed.
(d) Feed to primary cyclones preceding flotation.

TABLE 2. TYPICAL GRINDING-CIRCUIT OPERATING DATA

Pilot-Plant Treatment of Italian Run-of-Mine Talc

	Weights, Volumes, and Pulp Densities			
	Solids,	Slurry		New Water,
Circuit	lb/min	Solids, %	GPM	gpm
Pebble Mill				
New Feed (dry)	7.5	--		1
Discharge	--	51	9	--
No. 1 Cyclone				
Feed	57	22	27	18
Overflow	17	9	21	--
Underflow	40	53	6	--
No. 2 Cyclone				
Feed	17	8	25	4
Overflow	7.5	4	23	--
Underflow	9.5	42	2	--

TABLE 3. TYPICAL GRINDING-CIRCUIT OPERATING DATA

Pilot-Plant Treatment of Italian Run-of-Mine Talc

Grinding-Circuit Circulating Load

$$\text{Per cent circulating load} = \frac{\text{Weight cyclone underflow}}{\text{Weight new feed}} \times 100$$

New feed = 7.5 lb/min
Underflow, No. 1 cyclone = 40 lb/min
Underflow, No. 2 cyclone = 9.5 lb/min

$$\text{Per cent circulating load} = \frac{40 + 9.5}{7.5} \times 100 = 660\%$$

Grinding-Circuit Classification Efficiency
(At 200 Mesh)

Recovery of Minus 200-Mesh Fraction

$$\text{Efficiency, \%} = \frac{\text{Weight of minus 200-mesh No. 2 cyclone overflow}}{\text{Weight of minus 200-mesh No. 1 cyclone feed}} \times 100$$

$$\text{Efficiency, \%} = \frac{7.5 \times 0.98}{0.57 \times 0.609} \times 100 = 21.2\%$$

Rejection of Plus 200-Mesh Fraction

$$\text{Efficiency, \%} = \frac{(\text{Weight of plus 200-mesh No. 1 cyclone feed}) - (\text{Weight of plus 200-mesh No. 2 cyclone overflow})}{\text{Weight of plus 200-mesh No. 1 cyclone feed}} \times 100$$

$$\text{Efficiency, \%} = \frac{(57 \times 0.391) - (7.5 \times 0.02)}{57 \times 0.391} \times 100 = 99.3\%$$

Cyclone Operating Data

	Gpm Feed	Pressure, psig: Feed	Pressure, psig: Overflow	Pressure, psig: Underflow
No. 1 Cyclone(a)	27	22	2	(c)
No. 2 Cyclone(b)	25	16	6	(c)

(a) 4-inch short cyclone – 9/16-inch inlet, 1-inch vortex finder, 3/4-inch apex.
(b) 4-inch long cyclone – 3/4-inch inlet, 3/4-inch vortex finder, 3/8-inch apex.
(c) Free discharge.

BENEFICIATION

Beneficiation of the wet-ground ROM talc was started on October 19, 1959. The first circuit used was that employed in the concentration of Italian No. 2 talc. *

Microscopic examination of the froth from each cell showed that the talc being floated in all of the first 6 flotation cells was of good quality and that recirculation of the concentrate from Cells 5 and 6 (as practiced on Italian No. 2) was not necessary. Consequently, circuit changes were made which eliminated Float 2, the scavenger cyclones, and the scavenger flotation cells. Thus all 6 cells of the previous Float 1 and Float 2 circuits became Float 1.

After several hours of operation with this straight rougher (Float 1) circuit on October 21, it was apparent that insufficient quantities of flotation reagents were being used. (This was because there was now no circulating load to return reagents to the flotation circuit.) Additional amounts of reagents were added for the balance of the shift. The low weight recovery, 49 per cent, obtained on this day is believed to be the result of several hours of operation with insufficient reagents.

This circuit, as shown in Figure 2, was operated on October 22, November 3, and November 4 with no changes. On November 5 and 6 reagents were increased 10 per cent. The metallurgical results obtained during these 6 days of operation are given in Table 4. Recoveries of 60 to 65 per cent, based on plant feed, were obtained in producing a superior talc product.

Typical operating data are given in Figure 2 and Tables 5, 6, and 7. These include size analyses, weights, volumes, pulp densities, cyclone operating data, primary cyclone efficiency calculations, and flotation reagent quantities.

OPERATIONAL PROBLEMS

The usual start-up and break-in problems were encountered in the grinding circuit, but once these had been solved, the entire circuit ran smoothly. Minor problems that occurred, and should be kept in mind in designing a commercial plant, have been discussed in the Phase Report of December 30, 1959, "Design and Construction of a Talc Flotation Pilot Plant".

* Phase Report, "Pilot-Plant Beneficiation of Italian No. 2 Talc", March 1, 1960.

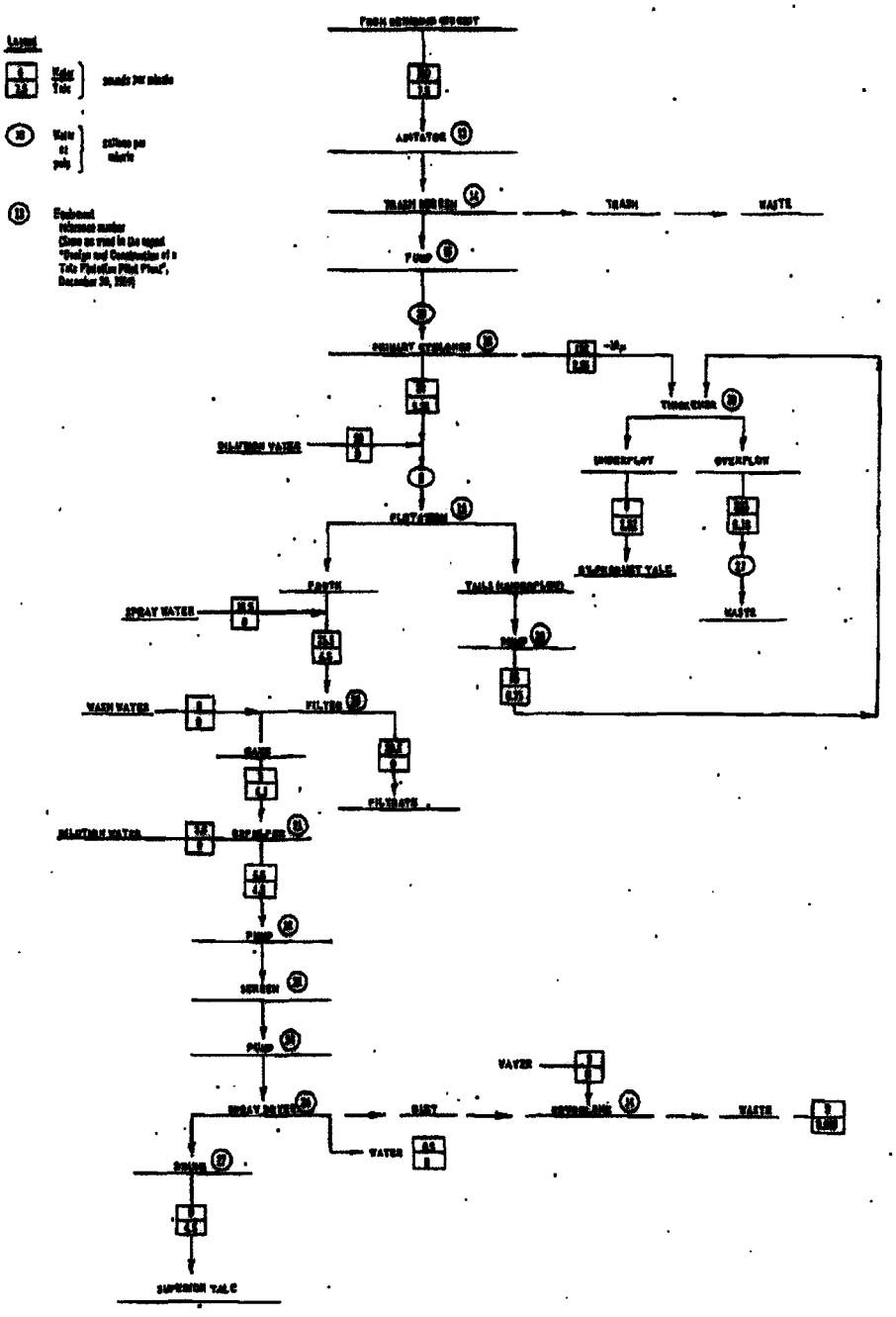

FIGURE 2. PILOT-PLANT FLOTATION-CIRCUIT FLOWSHEET FOR TREATMENT OF ITALIAN RUN-OF-MINE TALC

TABLE 4. SUMMARY OF PILOT-PLANT BENEFICIATION OF ITALIAN RUN-OF-MINE TALC

Date, 1959	Oct. 21	Oct. 22	Nov. 3	Nov. 4	Nov. 5	Nov. 6
Feed Rate, lb/hr	438	432	467	440	442	468
Operating Time, min	359	380	366	390	390	330
Feed[a]						
Platy Talc, %	91-92	91-92	91-92	91-92	91-92	91-92
CO_2, %	0.61	0.64	0.68	0.61	0.68	0.61
-10 Micron, %	29.5	29.6	27.0	25.2	28.9	26.2
Beneficiated Talc						
Platy Talc, %	99	99	99	99	99	99
CO_2, %	0.15	0.17	0.26	0.19	0.32	0.28
-10 Micron, %	9.0	10.4	13.0	13.6	13.0	12.4
Over-All Weight Recovery, %[b]	48.8	58.0	61.8	61.1	61.3	65.9
Luster	nd	nd	1.59	1.56	1.54	1.59
Combined Tailings[c]						
CO_2, %	1.05	1.29	1.36	1.27	1.25	1.25
-10 Micron, %	61.9	59.0	nd	nd	nd	nd

(a) Grinding-circuit cyclone overflow.
(b) Based on CO_2 analyses.
(c) Primary cyclone combined with flotation tailing.

TABLE 5. TYPICAL SIZE-DISTRIBUTION DATA, FLOTATION CIRCUIT[a]

Pilot-Plant Treatment of Italian Run-of-Mine Talc

Mesh	Primary Cyclones		Flotation Tailing	Combined Tailings[c]	Dryer Product
	U'flow[b]	O'flow			
+ 65	1.0	--	--	--	0.2
- 65+100	1.6	--	--	--	1.3
-100+200	0.6	--	--	--	1.0
-200	96.8	--	97.9	98.7	97.5
- 10 microns	9.4	71.2	15.4	59.0	10.4

(a) Run of October 28, 1959.
(b) Flotation feed.
(c) Floration tailing combined with primary cyclone overflow.

TABLE 6. TYPICAL PRIMARY-CYCLONE AND FLOTATION-CIRCUIT OPERATING DATA

Pilot-Plant Treatment of Italian Run-of-Mine Talc

Circuit	Weights, Volumes, and Pulp Densities			
	Solids, lb/min	Slurry		New Water, gpm
		Solids, %	GPM	
Primary Cyclones				
Feed	7.5	4	23	--
Overflow	2.25	1.4	20	--
Underflow[a]	5.25	7	9	6
Flotation				
Feed	5.25	7	9	--
Froth[b]	4.5	15	3	2
Tailing	0.75	1.3	8	--
Filtration				
Feed	4.5	15	3	1[c]
Filtrate	0	0	3.6	--
Cake	4.5	60	0.4	--
By-Product Thickener				
Feed	3.0	1.3	28	--
Overflow	0.18	--	27	--
Underflow	2.82	26	1	--

Primary Cyclone Classification Efficiency
(At 10 microns)

Rejection of Minus 10-Micron Fraction

$$\text{Efficiency, \%} = \frac{\text{Weight of minus 10 microns in cyclone overflow}}{\text{Weight of minus 10 microns in cyclone feed}} \times 100$$

$$\text{Efficiency, \%} = \frac{2.25 \times 0.712}{7.5 \times .296} \times 100 = 72.1\%$$

Cyclone Operating Data

	GPM	Pressure, psig		
		Feed	Overflow	Underflow
Primary Cyclones	23	32	10.5	6.5

(a) After dilution water.
(b) After launder spray water.
(c) Wash water on filter.

TABLE 7. TYPICAL FLOTATION-REAGENT DATA

Pilot-Plant Treatment of Italian Run-of-Mine Talc

	Flotation Reagents, pounds per ton new feed								
		Flotation Cells						By-Product	
Reagent	Conditioner	1	2	3	4	5	6	Thickener	Total
HCl, 37 %[a]	±1.0[e]								±1.0[e]
Dowfroth 250[b]	0.06	--	--	0.06	0.06	0.03	--		0.21
Aerosol 18[c]	0.24	--	0.24	--	0.12	--	--		0.60
Separan AP30[d]	--	--	--	--	--	--	--	0.10	0.10

(a) 10 % solution.
(b) 0.5 % solution.
(c) 2 % solution.
(d) 0.2 % solution.
(e) To pH 8.9-9.1.

[redacted]

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