

FREE-FALL ELECTROSTATIC SEPARATION OF PHOSPHATE
AND CALCITE PARTICLES

December 1966 Progress Report

Minerals Research Laboratory

Lab. Nos. 1869, 1890, 1985, 3021 & 3038 - Book 212

by

D. Grant Feasby

Introduction

A study was made to determine the feasibility of making a calcite-calcium phosphate separation by free-fall electrostatics. Large tonnages of North Carolina phosphate ore are being discarded due to high calcium content. This extra calcium is present chiefly as calcite which surrounds the phosphate pebble and quartz particles. Since the calcite is soft, liberation of all three constituents is possible with a low amount of mechanical energy.

Wet and dry methods are available for a quartz-phosphate separation, but no satisfactory methods are available for a complete calcite-phosphate separation. Such a separation is attempted in this work.

The work includes an investigation of the response of "synthetic" mixtures of calcite and phosphate pebble to electrostatics, and the variables which affect this response. Follow-up work was done on the actual low grade ore (Lab. No. 1869) in an attempt to utilize the conditions found favorable with the synthetic mixtures.

Clear-cut separations were obtained with the synthetics. However, the results showed only limited success in upgrading 1869. The best concentrate made from this ore analyzed 22.1 percent P_2O_5 and 2.6 percent insolubles, from a head feed of 8.2 percent P_2O_5 and 51.9 percent insolubles.

Feed Material

Synthetic mixtures were made using ground shell (Lab. No. 1985), coquina (Lab. No. unknown), and phosphate pebble flotation concentrate (Lab. Nos. 1890, 3021 and 3038). Narrow size fractions, usually minus 20 plus 48 mesh, of the above "calcite" and phosphate samples were mixed in 50/50 proportions for electrostatic tests.

Samples of Lab. No. 1869 were obtained from material remaining from flotation test work by W. T. McDaniel et al. Core samples had been roll crushed to minus 14 mesh. A considerable amount of fines were present in this material and it was removed by scrubbing at 70 percent solids and deslimed at 200 mesh. The plus 200 mesh material was dried at 170°C for several hours.

Method

Five-hundred-gram samples of the mixture or of the low grade ore were heated to 170°C for at least half an hour. The material was

fed to the separator at a low rate, usually about 250 grams per minute, and maintained close to 150°C with infrared lamps. Positive potentials of 25 KV were applied to the right electrode and the left electrode was maintained at ground potential.

The operation of the separator is described in more detail in the July 1966 Progress Report, Report C.

Results

Results are shown in Tables 1 and 2 at the end of the report. Table 1 gives the results of the best separations achieved on the synthetic mixtures. Poorer separations, and tests on some mixtures containing quartz, are not reported. The reported tests are those in which a sharp split was observed. Some anomalies in deflection (left or right) of the calcite and phosphate particles are reported.

The results shown in Table 1 indicate that a mixture of phosphate concentrate and "calcite" will separate electrostatically. The separation depends, of course, on surface conditions of the particles. Comparison of runs 108, 112, 118 and 121 shows the effects of conditioning with either acid, fatty acid, or fatty acid with fuel oil, on the separation of 1890 and 1985 material. Reagentizing of the phosphate alone with fatty acid and fuel oil, as in run 121, gave a good separation as would be expected. Runs 90 and 109 show that 3038 and 3021 phosphate concentrates reponded more readily than 1890. This may be due to these two being amine flotation concentrates. However, subsequent attempts to separate amine reagentized synthetic mixtures were unsuccessful. Other variables such as temperature, scrubbing, caustic and sulphuric acid leaching did not enhance a separation.

It can be seen in Table 1 that either calcite or phosphate may be deflected left or right, that is the phosphate, for instance, can accumulate a positive or a negative charge with respect to calcite. This evidence suggests that the semiconductive surface properties of both minerals are almost identical, and attempts should be made to radically change the surface properties of one of the minerals.

Table 2 shows the results of tests on Lab. No. 1869 low grade phosphate. The picture here is complicated by the wide range of size and by the presence of quartz. Attempts to apply the favorable conditions discovered with the synthetics were not successful. It was found that an acid scrub and a desliming step (minus 200 mesh) were best. Treatment with fatty acid or amine, with or without fuel oil, did not enhance separations. It was found that such steps caused good electrostatic separation of quartz from the phosphate-calcite mixture. The results are shown in Table 2, which gives percent weights and assays of each sample-pan fraction. Pans 1 to 4 of run 143 were combined to make feed for run 143-A and pans 1 to 6 of run 143-A were combined to make feed for run 143-B. In each case, this material was remixed to

uniformity and reheated and passed through the separator. Combined assays were obtained in some instances to shorten assay time. As an example of the grades and recovery obtained, pan 3 of run 143-B represents 9.8 percent of the head feed weight and assays 21.4 percent P_2O_5 , 2.0 percent insolubles, and 54.0 percent CaO. An estimate of the mineralogy of this sample based on the assays (pure phosphate = 31.5 percent P_2O_5) gives 68.0 percent phosphate pebble, 29.2 percent calcite and 2.0 percent quartz. The head feed is estimated to contain 26.0 percent phosphate pebble, 21.6 percent calcite and 51.9 percent quartz.

Summary

Possibilities exist for an electrostatic separation of phosphate from soft calcite, although such a process has not been developed by this work.

Such a separation would of necessity be achieved by preferential treatment of one of the minerals. This premise implies that flotation offers more promise than does electrostatic separation.

Table 1

Electrostatic Treatment of Synthetic Mixtures

Run No.	Feed Material		Variable	Deflection of Phosphate	Separation
	Mesh	Lab. No.			
90	-20+100 -20+100	1985, shell 3038, conc.	3038, not scrubbed	Right	Sharp
109	-20+48 -20+48	1985, shell 3021, conc.	3021, not scrubbed	Left	Sharp
110	-20+48 -20+48	coquina 3038, conc.	3038, not scrubbed	Left	Sharp
111	-20+48 -20+48	coquina 1890, conc.	1890, not scrubbed	Left	Sharp
108	-20+48 -20+48	1985, shell 1890, conc.	no separation		no
112	-20+48 -20+48	1985, shell 1890, conc.	1890, conc. Scrubbed with acid	Left	Fair
118	-20+48 -20+48	1985, shell 1890, conc.	*Condition together with 1#/ton Fatty Acid	Right	Fair
119	-20+48 -20+48	1985, shell 1890, conc.	Condition 1890 only with 1#/ton Fatty Acid	Right	Not as good as 118
120	-20+48 -20+48	coquina 1890, conc.	Cond. together with 1#/ ton Fatty Acid and 1 drop Fuel Oil	Left	Good
121	-20+48 -20+48	1985, shell 1890, conc.	Cond. 1890 only with 1#/ton Fatty Acid and 1 drop Fuel Oil	Left	Good
122	-20+48 -20+48	coquina 1890, conc.	Condition 1890 only as in 121	Left	Sharp

* Condition at 90% solids by tumbling for 2 minutes.

Table 2

Electrostatic Treatment of Low Grade Phosphate

Run No.	Pans											Head	
	1	Left Bars	2	3	4	5	6	7	8	Right Bars	8+		
143	% Wt.	16.3	4.9	8.0	15.1	9.9	7.4	4.5	7.4	13.4	6.5	6.7	100.0
	% P ₂ O ₅	13.9	15.4	20.2	14.5	9.0	7.1	13.7	1.7	0.6	1.8	0.5	8.2
	% Insol ^{**}	26.0	23.3	7.4	24.7	40.7	47.0	73.4	92.0	97.2	93.5	98.0	51.9
	% CaO	39.1	-	47.9	40.0	31.3	28.5	17.1	3.9	1.6	0.6	-	25.0
143-A	(Feed = Pans 1 to 4 of Run 143)												
	% Wt.	21.0	0.2	6.7	25.3	19.6	10.6	3.4	3.3	4.5	3.5	1.8	100.0
	% P ₂ O ₅		19.2		12.8		9.0				2.7		
	% Insol		7.5		10.7		18.8				90.3		
	% CaO		54.2		52.1		46.5				7.2		
143-B	(Feed = Pans 1 to 6 of Run 143-A)												
	% Wt.	11.7	none	2.6	21.0	23.4	26.4	7.7	3.4	2.2	1.4	0.2	100.0
	% P ₂ O ₅	18.6		22.1	21.4	13.8	9.4	8.7	6.3		3.7		
	% Insol	3.0		2.6	2.0	2.9	5.7	12.1	55.9		80.5		
	% CaO	-		54.5	54.0	55.6	52.0	50.0	24.3		11.2		

* Considerable difficulty was experienced with the build-up of fines on the electrodes.

** CaO analyses are believed to be as much as 6% too high.