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ELECTROSTATIC SEPARATION OF NORTH CAROLINA PHOSPHATES

by

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ABSTRACT

Electrostatic separation tests on quartz-bearing phosphate samples obtained from Texasgulf's Lee Creek operation gave results comparable with flotation results. Electrostatic separation requires completely dry feed that is heated to high temperatures; this could make it particularly suitable for beneficiation of calcined material. However, poor separations were obtained with calcined phosphate. Flotation feed and single-float concentrate products were separated effectively using electrostatics, but heating requirements and power consumption make this beneficiation method impractical for this type of material.

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Lab Nos. 4736, 4737, 4738 - Notebook No. 433

INTRODUCTION

Duplicate phosphate samples were provided by Texasgulf Inc. for the purpose of studying the application of electrostatic separation. One set of samples was sent to Kali and Salz A.G. in West Germany, and one set was sent to North Carolina State University Minerals Research Laboratory in Asheville, North Carolina. The results obtained by both laboratories will be compared at a later date.

It is desired to reduce the insoluble matter in the single-float calcined material. Since this material is heated during calcination, electrostatic separation could be an approach to upgrade the material.

EQUIPMENT

The high tension separator used in these tests was a Carpco Model HP16-114 panel type separator. This device was designed specifically for use in high voltage separation studies. Conditions such as diameter of rotors, electrode positions, voltage gradients, polarities and field shapes can be changed to investigate the effects of such variables.

The rotor speed can be adjusted from zero to 600 revolutions per minute and a heating coil is built into the feed hopper to maintain elevated temperatures. The rectifier contained in this device provides either positive or negative voltage from zero to 43,000 volts, which is passed through a pair of electrodes that can be placed in a variety of positions in relation to the rotating rotor.

TABLE 1

ANALYSES OF PHOSPHATE SAMPLES

Sample	Lab No.	P_2O_5	CaO	AI	MgO	Fe_2O_3	Al_2O_3
Float Feed	4736	16.25	26.22	45.67	0.44	0.26	0.26
65C	4737	29.29	46.74	12.50	0.68	0.74	0.40
Single-Float Conc.	4738	26.57	42.38	13.89	0.56	0.29	0.32

SAMPLES AND SAMPLE PREPARATION

The three phosphate samples utilized in this study were provided by Texasgulf Inc. from the Lee Creek operation. They were: flotation feed (Lab 4736), single-float concentrate (Lab 4738),and single-float calcined material (Lab 4737, Texasgulf 65C). Detailed chemical analyses of these samples are provided in Table 1.

On receipt, the flotation feed and single-float concentrate contained approximately 16% moisture. They were separately dried overnight at 200° F so that proper sampling could be accomplished. Each of the three dried samples was split into 12 equal portions of approximately 750 grams each, with a rotary splitter. The +US 50 material was removed from the 750-gram samples to prevent clogging of the hopper feeding the electrostatic separator. The individual samples were placed in pans and heated in gas ovens to 225° C for 12 hours to insure uniform temperature. The samples could then slowly be cooled to the desired temperature for each test.

PROCEDURE

Once the rotor speed was set and recorded, a dried, unheated sample was poured into the hopper. The feeder gate was opened and the material poured onto the rotor and into collecting pans. The right splitter was adjusted to the position that allowed all material thrown from the rotor to be collected in the middling section. This was done so that when voltage was introduced it would have a "lifting" effect on either the quartz particles or the phosphate particles, depending on the charge that was applied. This "lifting" effect would pull the desired particles over the splitter so that they would be collected in the "thrown" section.

Having all variables set and recorded, a hot sample was removed from the oven and allowed to cool to a desired temperature. This sample was placed in the feed hopper, the proper voltage was applied, and the feed gate was opened. The feed rate was maintained at 100 grams per minute to allow for reproducibility. After the entire sample had passed by the electrodes, the machine was turned off and the collecting chutes were cleaned. Samples were weighed, split for assay, and the phosphate-bearing sample was returned to the oven to be heated so that a cleaner separation could be completed.

RESULTS

The following tables present the most informative data obtained by the 50 tests that were conducted. Since the main area of interest was to reduce the amount of insoluble matter (A.I.) in each sample, chemical analysis was employed to determine only the insoluble matter.

In tests using the flotation feed, the insoluble matter was reduced from 45.67% to 14.8% with one pass through the electrostatic separator. A cleaner pass provided a concentrate that had only 7.4% A.I. (Table 2).

Single-float concentrate containing 13.89% A.I. was reduced to 4.8% A.I. with one pass, and one cleaner pass reduced the insoluble matter to as low as 3.4%. Additional cleaner passes did not reduce the

A.I. by any appreciable amounts (Table 3).

The most intensively studied sample was the 65C calcined material, but unfortunately it did not provide the success that the other samples did. A head assay of 12.50% A.I. was reduced to 10.5% A.I. using 30 kilovolts and one cleaner pass (Table 4).

DISCUSSION

After numerous unsuccessful attempts to make a separation, it was determined that an exaggeration of the "lifting" effect mentioned previously would be beneficial. To accomplish this, the wire electrodes were rotated 180^{o} to distribute the electrical charges across the roll holding the wire (Figure 1, Electrode Position 2). This provided much sharper separations than Electrode Position 1.

The sharpest separations were obtained by using a negative ground and a positive charge on the particles. This arrangement resulted in the quartz particles being "lifted" from the rotor and being thrown into the hopper designated as thrown material. A positive ground and negative particle charge yielded poor results in comparison with the opposite arrangement.

Electrode position was another critical variable. If the electrodes were placed within 4 inches of the rotor surface, arcing occurred and hence no separation. Best results were obtained in most cases by placing the lower electrode perpendicular to the point of tangency where the material stream loses contact with the rotor. Placement of the upper electrode did not seem as critical, but it was evident that particles should be charged while in contact with the rotor. A rotor speed of 45 rpm yielded the most satisfactory results. Both higher and lower speeds were investigated, but separations were poor in each case. Other variables were not investigated because of the short duration of this project.

It should be mentioned that the phosphate products in the most successful tests reported to the middling hopper; that is, they were neither "pinned" nor "thrown". Optimum results were obtained by "lifting" the

TABLE 2

ELECTROSTATIC SEPARATION OF FLOTATION FEED

Sample	Test 2 Wt %	Test 2 A.I.	Test 2 Dist. A.I.	Test 4 Wt %	Test 4 A.I.	Test 4 Dist. A.I.
Thrown	39.5	96.3	80.3	33.0	95.3	64.8
Mids	57.5	14.8	18.0	65.5	25.2	34.0
Pinned	3.0	26.5	1.7	1.5	37.6	1.2
Calc. Head	100.0	47.3	100.0	100.0	48.5	100.0
Cl. Thrown	12.0	68.7	54.3	5.0	85.6	16.6
Cl. Mids	86.7	7.4	42.4	94.4	22.6	82.5
Cl. Pinned	1.3	41.2	3.3	0.6	37.6	0.9
Calc. Head	100.0	15.2	100.0	100.0	25.8	100.0

Variable	Test 2	Test 4
Feed Temp (^{o}C)	180	180
Electrode Distance from Rotor (in.)	4	4
Kilovolts	40	20
Ground	neg	neg
Angle of Lower Electrode	22^{o}	17^{o}
Angle of Upper Electrode	43^{o}	40^{o}
Position of Left Splitter	60	25
Position of Right Splitter	52	52
rpm of Rotor	45	45

TABLE 3

ELECTROSTATIC SEPARATION OF SINGLE-FLOAT CONCENTRATE

	Test 1			Test 5			Test 9		
Sample	Wt %	A.I.	Dist. A.I.	Wt %	A.I.	Dist. A.I.	Wt %	A.I.	Dist. A.I.
Thrown	12.3	77.5	63.0	9.2	81.2	51.7	9.8	67.3	42.1
Mids	84.5	4.8	26.7	90.2	7.52	46.9	89.6	9.9	56.6
Pinned	3.2	48.9	10.3	0.6	33.6	1.4	0.6	33.9	1.3
Calc. Head	100.0	15.2	100.0	100.0	14.5	100.0	100.0	15.7	100.0
Cl. Thrown	2.8	42.6	26.4	2.6	78.7	27.4	11.3	31.4	36.0
Cl. Mids	96.9	3.4	71.9	97.2	5.50	71.5	88.2	7.0	62.5
Cl. Pinned	0.2	36.0	1.7	0.2	37.6	1.1	0.5	28.9	1.5
Calc. Head	100.0	4.6	100.0	100.0	7.47	100.0	100.0	9.9	100.0
2nd Cl. Thrown	-	-	-	1.2	38.0	8.1	-	-	-
2nd Cl. Mids	-	-	-	98.7	5.28	91.9	-	-	-
2nd Cl. Pinned	-	-	-	0.1	2.62	-	-	-	-
Calc. Head	-	-	-	100.0	5.67	100.0	-	-	-

Variable	Test 1	Test 5	Test 9
Feed Temp (°C)	180	180	180
Electrode Distance from Rotor (in.)	5 1/8	4	4
Kilovolts	40	20	25 rougher 40 cleaner
Ground	neg	neg	neg
Angle of Lower Electrode	17°	17°	17°
Angle of Upper Electrode	40°	40°	40°
Position of Left Splitter	25	25	25
Position of Right Splitter	52	52	52
rpm of Rotor	45	45	45

TABLE 4

ELECTROSTATIC SEPARATION OF 65C

Sample	Test 10 Wt %	Test 10 A.I.	Test 10 Dist. A.I.	Test 11 Wt %	Test 11 A.I.	Test 11 Dist. A.I.	Test 12 Wt %	Test 12 A.I.	Test 12 Dist. A.I.
Thrown	93.3	12.7	93.8	92.0	12.7	95.1	11.4	23.2	20.4
Mids	3.8	14.9	4.5	5.6	9.5	4.3	86.9	11.8	79.1
Pinned	2.9	7.2	1.7	2.4	3.3	0.6	1.7	3.7	0.5
Calc. Head	100.0	12.6	100.0	100.0	12.3	100.0	100.0	13.0	100.0
Cl. Thrown	-	-	-	-	-	-	4.6	19.3	8.2
Cl. Mids	-	-	-	-	-	-	94.1	10.5	91.3
Cl. Pinned	-	-	-	-	-	-	1.3	4.28	0.5
Calc. Head	-	-	-	-	-	-	100.0	10.8	100.0

Variable	Test 10	Test 11	Test 12
Feed Temp (^{o}C)	180	180	180
Electrode Distance from Rotor (in.)	5 1/8	6	4
Kilovolts	43	43	30
Ground	pos.	pos.	neg.
Angle of Lower Electrode	19^{o}	17^{o}	17^{o}
Angle of Upper Electrode	42^{o}	40^{o}	40^{o}
Position of Left Splitter	60	25	25
Position of Right Splitter	49	52	52
rpm of Rotor	45	45	45

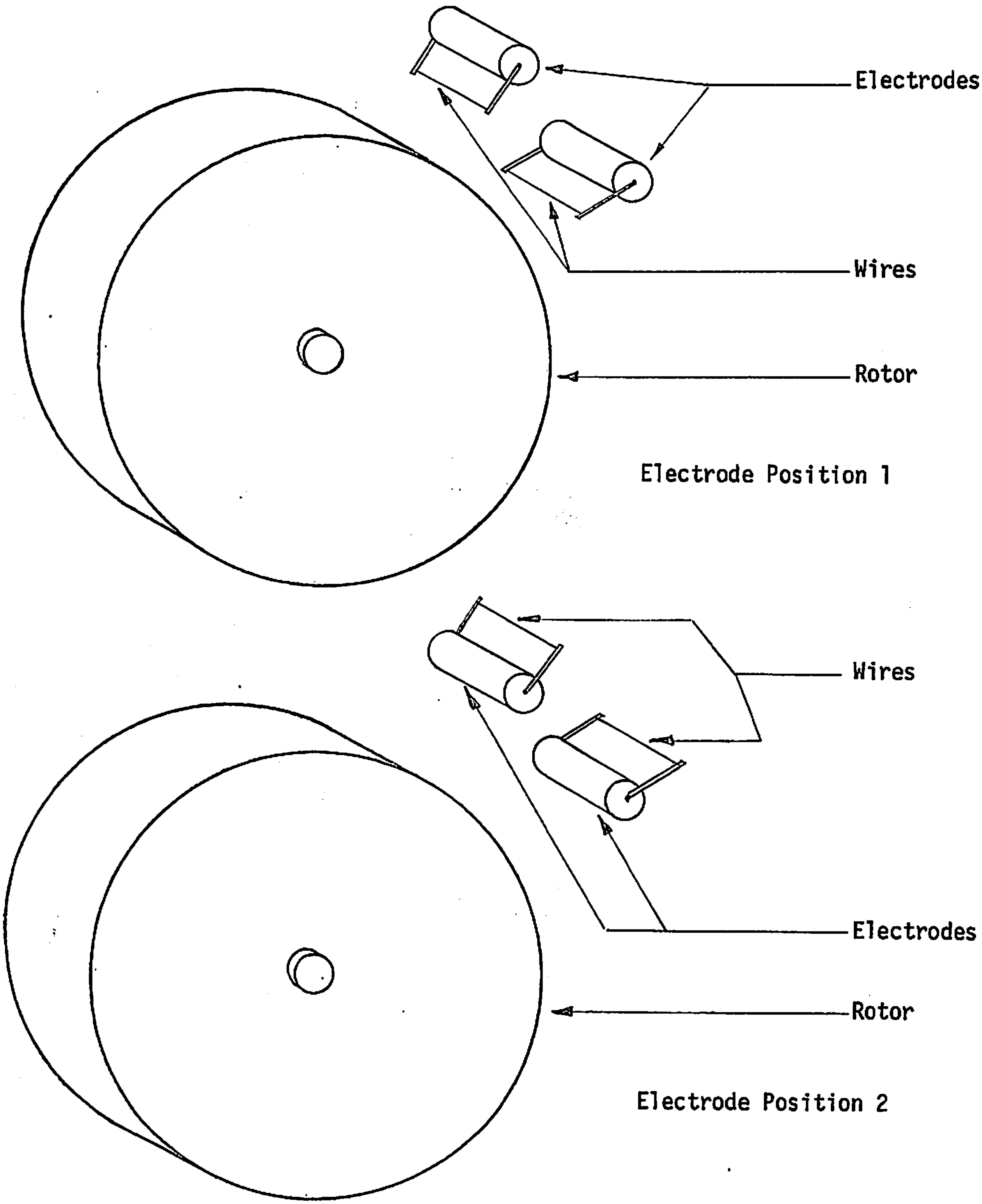

Figure 1 - Electrode positions.

quartz from the rotor. The very small quantity of material that reported to the "pinned" hopper was quite fine, indicating a sizing separation rather than a phosphate/quartz separation.

CONCLUSIONS

Separation of phosphate and quartz is possible with electrostatics as well as flotation. Since the feed for this separation must be completely dry, the costs of drying large tonnages of material are prohibitive. However, the advantages of dry processing should not be overlooked, particularly with respect to water reclamation problems that could be avoided.

Electrostatic separation would be ideal for upgrading calcined phosphate since the material is already dried and heated to high temperatures during calcination. The techniques presented in this report provided poor separations on the calcined material, but a more detailed investigation may be warranted. This investigation could be focused on either the electrostatic removal of insoluble material or the removal of calcium-bearing material. Removal of either contaminant would result in a higher grade product.

SUGGESTIONS

Based on the findings of this report, the following areas of future research may be suggested.

1) Investigation of different variables, such as using different size rotors or additional electrode configurations.

2) Reagentizing the material to enhance its electrically conductive characteristics.

3) Sizing material more closely so that the various feed materials would be more uniform.

4) Employ the use of various electrostatic separators so that more than 3 products can be obtained for closer examination of the differences between the products (i.e. free-fall separator).

5) Investigate electrostatic techniques for the removal of calcium-bearing material.