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PHOSPHATE DEPOSITS KAPUNDA
Beneficiation by Flotation

by

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to

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DEPARTMENT OF MINES

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CONTENTS

1. INTRODUCTION

This investigation was carried out as part of a general investigation made by the Industrial Chemistry Section for the recovery of phosphate from low grade phosphatic rock from Kapunda.[1]

When it was found that the main phosphate mineral was apatite, the sponsor requested that the possibility of using flotation to make a preliminary concentration of the apatite should be examined.

2. SUMMARY

A sample of phosphatic rock from Kapunda in which the main phosphate mineral was apatite, was subjected to a series of flotation tests with anionic and cationic reagents under various conditions. No significant concentration of apatite was obtained.

3. MATERIAL EXAMINED

The sample used for the investigation was one of a suite of samples supplied by the Department of Mines, Adelaide. The sample was labelled:

Average Grade Bulk (1 and 2) Phosphate, Sec. 105 Hd. Moororoo,

and had the following assay:

		%
Iron as	Fe_2O_3	20.9
Phosphorus as	P_2O_5	21.2

4. EQUIPMENT

The major equipment used included:

1. 10 x 6-inch crushing rolls.
2. Laboratory stainless steel rod mill 10 inch long, $7\frac{1}{2}$ inch inside diameter with 10, 1-inch diameter rods.
3. Laboratory Fagergren flotation cell (500 g capacity)
4. BSS screens

5. ANCILLARY MATERIALS

Anionic and cationic flotation reagents were used in the tests.

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1. Report AMDL-205 "Phosphate Deposits Kapunda, Production of Phosphoric Acid", by F.J. Moyle.

5.1 Anionic Reagents

Two different emulsions were tested and their composition was as follows:

		%
1.	Tall oil A.1. *[1]	19
	Fuel oil[2]	75
	Naphthenic acid[2]	4
	Nonion P100[3] (octylphenol oxyethylene condensate)	2
2.	Linseed fatty acids[4]	20
	Sulphonated whale oil[3]	12
	Fuel oil[2]	64
	Cresylic acid[5]	4

5.2 Cationic Reagent

Armac 16 (hexadecyl amine acetate, produced by Armour Chemical Division, Chicago) was used with Aerofroth 65 (produced by American Cyanamid Co., New York) as a frother.

6. EXPERIMENTAL PROCEDURE RESULTS AND DISCUSSIONS

6.1 Grinding

The ore was crushed in a set of rolls to minus 10-mesh. This material was then thoroughly mixed and 500 g samples were riffled out for grinding. Grinding was done in a stainless steel rod mill and with a pulp containing 60 per cent solids by weight.

A screen analysis of the sample after crushing and distribution of P_2O_5 in fractions are shown in Table 1. Screen analyses of ground products are given in Table 2.

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* Reagents were supplied by:

1. A.C. Hatrick Pty. Ltd., Torrensville, S.A. Tall oil A.1. is a Swedish Crude Tall oil containing 43 per cent resin acids.
2. Shell Chemical Company, Adelaide.
3. Gardinol Chemical Co. (A'Asia) Pty. Ltd., Enfield, S.A. Sulphonated whale oil is marketed under the trade name: "Peltogen".
4. Meggitt Ltd., Port Adelaide
5. Union Carbide Aust. Ltd., Adelaide

TABLE 1: SCREEN ANALYSIS OF CRUSHED MATERIAL

Mesh BSS	Weight %	P_2O_5 %	Distribution of P_2O_5 %
+ 100	9.9	26.5	13.0
- 100 + 150	19.2	21.5	20.9
- 50 + 200	7.8	17.7	7.0
- 200	63.1	18.3	59.1
Feed (calc)	100.0	19.7	100.0

TABLE 2: SCREEN ANALYSES OF GROUND PRODUCTS

Mesh BSS	Grinding Time (minutes)			
	5 Wt. %	15 Wt. %	25 Wt. %	40 Wt. %
+ 52	0.3	-	-	-
- 52 + 72	2.4	-	-	-
- 72 + 100	7.2	0.3	0.1	-
- 100 + 150	19.2	1.6	0.2	-
- 150 + 200	7.8	1.8	0.1	-
- 200	63.1	96.3	99.6	100.0

6.2 Anionic Flotation

Except where otherwise noted, the following conditions applied in all tests with anionic emulsions:

Temperature	:	25°C
pH	:	8
Pulp density	:	17 per cent solids
Conditioning	:	in rod mill
Rougher flotation time.	:	10 minutes

Adelaide tap water was used in all tests. Sorbitan mono-oleate was used when necessary to control frothing.

A series of tests was conducted to determine the effect of reagent amount, particle size, pH and multiple cleaning.

6.2.1 Effect of Reagent Amount

Tests were conducted to determine the effect of quantity of reagent used. Feed was ground to 63.1 per cent minus 200-mesh. Conditions and results are shown in Table 3.

TABLE 3: ANIONIC FLOTATION: EFFECT OF REAGENT AMOUNT

Reagent Type	Reagent lb/ton	Feed P_2O_5 % (calc)	Concentrate		
			Weight %	Assay P_2O_5 %	Distribution of P_2O_5 %
Linseed fatty acid	6.25	20.9	55.7	24.7	65.5
- ditto -	12.5	20.8	66.4	24.3	77.5

The results show that the reagent is largely non-selective. Increasing the amount improves recovery but the per cent weight floated increases proportionately.

6.2.2 Effect of Particle Size

The effect of grinding was examined in 2 tests, in which 12.5 lb of linseed fatty acid emulsion were used per ton of feed ground to 63.1 and 99.6 per cent minus 200-mesh.

Conditions and results are shown in Table 4.

TABLE 4: ANIONIC FLOTATION: EFFECT OF PARTICLE SIZE

Minus 200-Mesh	Reagent lb/ton	Feed P_2O_5 % (calc)	Concentrate		
			Weight %	Assay P_2O_5 %	Distribution of P_2O_5 %
63.1	12.5	20.8	66.4	24.3	77.5
99.6	12.5	21.0	29.9	23.5	47.0

The results indicate that flotation is unselective at both coarse and finer particle sizes.

6.2.3 Effect of pH

Eidsmo and Mellgren (1960) reported that flotation of apatite with tall oil at pH 9.0 - 10.0 was successful.

A test was conducted using 16.7 lb of the tall oil emulsion per ton of feed at pH 9.8. To obtain the desired pH of 9.8 sodium hydroxide was used (2.5 lb/ton). A similar test was made at pH 8.0 (ie., without addition of sodium hydroxide) for comparison.

Conditions and results of tests are shown in Table 5.

TABLE 5: ANIONIC FLOTATION: EFFECT OF pH

pH	Reagent lb/ton	Feed P_2O_5 % (calc)	Concentrate		
			Weight %	Assay P_2O_5 %	Distribution of P_2O_5 %
9.8	16.7	21.0	62.2	23.6	69.6
8.0	16.7	21.1	57.3	24.0	65.0

Test results show no significant improvement at the higher pH.

6.2.4 Effect of Multiple Cleaning

An attempt was made to improve the grade of apatite by recleaning without further reagent addition. Flotation times were:

	Minutes
Roughing	10
Cleaning	4
Recleaning	2

Results are shown in Table 6.

TABLE 6: ANIONIC FLOTATION: EFFECT OF MULTIPLE CLEANING

Test Conditions	Fractions	Weight %	Assay P_2O_5 %	Distribution of P_2O_5 %
63.1 % minus 200-mesh	Recleaner concentrate	18.2	26.7	23.0
	Recleaner tailing	21.7	24.0	24.0
Linseed fatty acid mixture 12.5 lb/ton	Cleaner tailing	19.4	20.2	19.4
	Rougher tailing	40.7	17.3	33.6
	Feed	100.0	21.0	100.0
100 % minus 200-mesh	Recleaner concentrate	26.7	26.6	33.6
Linseed fatty acid mixture 16.7 lb/ton	Recleaner tailing) Cleaner tailing)	30.6	21.7	31.4
	Rougher tailing	42.7	17.3	35.0
	Feed	100.0	21.1	100.0

Test results show that any increase of grade would considerably reduce recoveries.

6.3 Cationic Flotation

The flotation tests were conducted by using Armac 16 on undeslimed (Test 1) and on deslimed material, (Test 2). The samples were ground to 63.1 per cent minus 200-mesh.

The desliming was done by decantation. The ground pulp was agitated in a bucket and allowed to settle for 8 minutes. This was repeated 3 times. To prevent flocculation sodium silicate and sodium hydroxide in equal amounts (10 lb of each per ton) were added to the pulp. The slime fraction had a sizing of minus 2 microns (nominal, based on the specific gravity of quartz). The coarse fraction was washed 3 times before flotation.

Armac 16 was added stagewise to the flotation cell and Aerofroth 65 was used as necessary to improve froth conditions.

Test conditions were:

Conditioning time (in cell)	:	1 minute
Reagent addition (Armac 16)	:	
Concentrate 1		0.5 lb/ton
Concentrate 2		1.0 "
Flotation time	:	
Concentrate 1		6 minutes
Concentrate 2		6 "

Results are shown in Table 7.

TABLE 7: RESULTS OF CATIONIC FLOTATION

Test No.	Product	Weight %	Assay P_2O_5 %	Distribution of P_2O_5 %
1	Concentrate 1	11.7	21.4	11.9
	Concentrate 2	11.7	20.5	11.5
	Tailing	76.6	21.0	76.6
	Feed (calc)	100.0	20.9	100.0
2	Slime	20.2	21.3	20.9
	Concentrate 1	10.8	16.4	8.6
	Concentrate 2	7.0	14.2	4.8
	Tailing	62.0	21.8	65.7
	Feed (calc)	100.0	20.6	100.0

Results showed no significant concentration.

7. CONCLUSION

The results show that only a slightly enriched apatite can be produced by flotation.

8. REFERENCES

EIDSMO, O., and MELLGREN, O., "Some factors which influence ilmenite flotation at Titania A/D., Norway". International Mineral Processing Congress, 1960 (The Institute of Mining and Metallurgy, London, 1960).