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FLOTATION OF PHOSPHATE ROCK

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This invention relates to the flotation of phosphate rock and more particularly to the type of pebble phosphate which is mined in Florida.

In the past, phosphate rock and particularly pebble phosphate has been floated, using caustic soda, hydrocarbon oil and an organic acid as reagents. The process has achieved great commercial success and a large proportion of the phosphate sold is produced by flotation. Phosphate rock is a highly competitive material and the margin of profit is small. This presents a severe problem in the flotation of phosphate rock because costs must be kept down and grades kept up or the material produced by flotation cannot sell in competition with coarser rock produced by washing. In fact, in most properties the rock is treated in the so-called washers, the coarse material sold and the finer material either thrown away or deslimed and beneficiated by flotation. In many cases the margin between profit and loss lies in floating the otherwise rejected finer material at a sufficiently low cost to make it salable. The low price which the finished product commands has required floating at minimum cost. The so-called fine material, —20 mesh, would be considered coarse flotation feed in ordinary ore dressing as it ranges from —20 to plus 200 mesh. Hitherto this material has been floated in a single float.

According to the present invention it has been found that notable improvements are obtained if the flotation feed is split by any suitable classification into a plurality of size bands, for example, from about —20 to plus 65 and —65 to plus 200, and in another example plus 35, —35 plus 65, and —65 plus 200 mesh, and the size ranges floated separately in separate strings of flotation machines, using somewhat different proportion of reagents. Three important advantages are obtained. First, the amount of reagents and hence the cost per ton is decreased. Second, the grade is improved, and third, the recovery is increased. The second and third factors are to some extent interdependent, that is to say, a considerable increase in grade can be obtained with the same recovery or the same grade can be obtained with a considerably greater recovery. Usually a compromise between the two is preferred which results in an increase of grade and an increase in recovery. The actual numerical saving in each of the three groups taken by itself does not appear impressive, but when the savings are cumulated the saving is important particularly because a large premium is paid for increases in grade and the present invention permits obtaining better grade with better recovery and lower reagent costs than in the prior practice. The saving in reagent cost per ton of concentrates is 15% in typical examples and the improved grade obtainable together with the some-

what higher recovery represents a further important saving. The total saving is sufficient so that in the case of certain borderline deposits, that is to say, deposits where the cost of mining and beneficiation by flotation by the former procedures are close to the sales price of the product, it is possible to operate at a profit deposits which were valueless.

The present invention should not be confused with desliming which is standard practice in the flotation of many ores and in the prior phosphate rock flotation processes. The flotation feed before classifying is already partially deslimed, the cut being usually taken at about 200 mesh. Although this may vary somewhat with different phosphate deposits the division of the deslimed material into a plurality of size ranges which is one of the main features of the present invention, has nothing to do with the desliming itself although it is perhaps possible to construct a classification apparatus which could perform the desliming and classification in one operation. The present invention is, of course, not concerned with any particular type of classification apparatus and therefore includes any suitable means for dividing the deslimed flotation feed into a plurality of size ranges which are then floated under the conditions best adapted for maximum efficiency with each size range.

The invention will be described in conjunction with the following specific examples which in the first case represents a composite of 66 flotation tests made on 22 samples of feed from different parts of a Florida phosphate rock deposit. In the second case a particular portion of mine pit flotation feed was split into three size bands. It will be understood that the invention is not limited to the details set forth in the examples and that the procedure and also the results obtained and the savings will vary with different phosphate deposits. In every case, the present process represents an improvement but in some case the improvement is economically more important than in others. It is an advantage of the present invention that it is applicable generally to any phosphate rock suitable for flotation.

Example 1

Sixty-six flotation tests were run on 22 samples deslimed phosphate rock flotation feed (—20 mesh plus 200 mesh) taken from a typical Florida phosphate deposit. All tests were made in the standard Fagergren flotation machines used for the floating of phosphate rock fines from this deposit and flotation time and other factors not specifically set forth in the following tables were kept identical. In the first series of tests the entire feed was floated. In the second series, the feed was classified to separate it at approximately 65 mesh and the two feeds were floated

separately in separate strings of flotation machines, the two strings, however, being identical in number and arrangement. Metallurgical results and reagent consumption have been com-
 5 posited in the following table. This procedure is necessary because phosphate deposits are not completely uniform and slight variations will be noted from day to day as different parts of the deposit are mined. To obtain reliable results, a
 10 number of floats must be made and the results composited:

Metallurgical results

15	Florida	T. P. A. feed	T. P. A. conc.	B. P. L.	Ratio	Insol- uble
	-20 plus 200.....	12,521	3,981	76.79	3.15	3.97
	-20 plus 65.....	7,137	2,463	77.07	2.90	3.25
	-65 plus 200.....	5,384	1,735	77.55	3.10	3.13
20	Composite.....	12,521	4,198	77.27	2.98	3.20

Reagent consumption

25	Florida	Caustic, lbs. per ton	Rosin, lbs. per ton	Fuel oil, lbs. per ton	Fish acid, lbs. per ton
	-20 plus 200.....	0.43	0.12	3.08	1.07
	-20 plus 65.....	0.40	0.12	2.90	1.03
	-65 plus 200.....	0.38	0.12	2.76	0.98
30	Composite.....	0.39	0.07	2.84	1.01

It will be noted that the biggest reagent saving and improvement in grade is obtained in the floating
 35 of the finer sample but the greatest increase in weight recovery is obtained in the coarser sample. The saving represented by the above tables is approximately 15% of the reagent cost per ton of concentrate.

Example 2

A portion of representative flotation feed, (-20 mesh plus 200 mesh), from a Florida mine pit was split into three size fractions and each fraction floated separately in a standard Fagergren flota-
 45 tion machine. The unclassified material was floated under identical conditions of treatment so that no variable except size range could enter into the comparisons.

Metallurgical results

50	Concentrates		Tails B. P. L.	Ratio	Recov- ery, percent	Distri- bution, percent
55	B. P. L.	Insol.				
	Plus 35.....	77.38	4.55	4.18	2.87	90.7
	-35 plus 65.....	77.62	4.06	5.35	3.69	84.4
	-65 plus 200.....	76.77	4.75	5.26	2.17	92.5
	Composited.....	77.39	4.35	4.92	3.02	88.5
60	Unsize 1.....	72.92	9.79	3.94	2.62	91.8
	Unsize 2.....	76.58	5.35	10.38	3.34	75.9

Reagent consumption

65		Caustic, lbs. per ton	Fuel oil, lbs. per ton	Fish acid, lbs. per ton
	Plus 35.....	2.98	26.4	5.17
	-35 plus 65.....	1.31	13.0	2.61
	-65 plus 200.....	.95	9.3	1.74
70	Composited.....	1.94	18.4	3.56
	Unsize 1.....	1.50	18.8	3.75
	Unsize 2.....	1.70	16.6	3.10

In this example it will be noted that in order to
 75 obtain a recovery with the unsize material equal-

ling that obtained with the three size bands that the grade of concentrate was greatly reduced. Conversely, in attempting to obtain a grade of concentrate with the unsize material to equal that of the three size bands the recovery was much
 5 lower.

In the examples, a typical commercial reagent combination is described. The constituents may, of course, be varied. Thus, for example, oleic acid in place of the fish acid gives somewhat better recoveries and grade but the cost of oleic acid is so much greater than that of fish acid that the slightly improved results are more than offset. Instead of the fish acid, crude mixtures of rosin and fatty acids such as those present in talloel or its
 15 semi-refined products may be used and these mixtures give somewhat better results at lower reagent cost. Other cheap sources of organic acids, particularly unsaturated acid may likewise be employed and similar results are obtained. It should
 20 be understood, of course, that the results will not be identical as there are slight variations with changes of reagent, and of course, different phosphate deposits will give somewhat different results.

The present invention is not concerned with any particular reagent combination, the examples setting out a typical commercial mixture. It is an advantage of the invention that it is generally applicable to various reagent combinations and does
 30 not require special reagents for success.

While the present invention is applicable to the flotation in any type of flotation machines, we have found that the best results are obtained with standard Fagergren flotation machines employing
 35 a very rapid skimming of the froth. Acceptable results on the finer size range can also be obtained in other types of flotation machine, but the high recoveries in the coarser size range which is possible in the Fagergren machine has not been obtained in other types. In a preferred modification, therefore, at least the coarse size range is floated in machines of the Fagergren type.

The invention has been described specifically in connection with the classification where cuts were made in the first case at 65 mesh, and in the second case at 35 and 65 mesh. The process of this invention is not critical for a definite mesh but broadly covers any suitable size classification or grouping of sizes to produce the desired result.
 50 Satisfactory results are obtained when the cut is as low as about 48 mesh or as high as 80. The 65 mesh is not a critical point but represents the best point to make a cut within the useful range given above and is therefore the preferred modification of the present invention. In practice, the sizing is usually done by wet classifiers and the cut is not quite as sharp as is the case with a screen in the laboratory. In referring to mesh size, therefore, it is intended to cover the ordinary classification
 60 method which includes a small percentage of material above or below the specified mesh size in the coarse and fines, respectively.

This application is in part a continuation of our prior co-pending application, Serial No. 108,374, filed Oct. 30, 1936.

What we claim is:

1. A method of floating phosphate rock which comprises classifying the rock into at least two size ranges between 20 and 200 mesh, at least one
 70 sizing cut being in the range between about 48 mesh and 80 mesh and subjecting each range separately to froth flotation.

2. A method of floating phosphate rock which comprises classifying the rock into two size ranges
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approximately -20 plus 65 mesh and -65 plus 200 mesh, and subjecting each range separately to froth flotation.

3. A method of floating phosphate rock which comprises classifying the rock into at least two size ranges between 20 and 200 mesh, at least one sizing cut being in the range between about 48 mesh and 80 mesh and subjecting each range separately to froth flotation, the coarsest range being floated with a reagent concentration not exceeding that necessary for floating the whole range.

4. A method of floating phosphate rock which comprises classifying the rock into two size ranges approximately -20 plus 65 mesh and -65 plus 200 mesh and subjecting each size range separately to froth flotation, the coarsest range being floated with the reagent concentration not exceeding that necessary for floating the whole range.

5. A method of floating phosphate rock which comprises classifying the rock into at least two size ranges between 20 and 200 mesh, at least one sizing cut being in the range between about 48 mesh and 80 mesh and subjecting each range separately to froth flotation, the finest range being floated with a reagent concentration materially less than that necessary for floating the whole range.

6. A method of floating phosphate rock which comprises classifying the rock into two size ranges approximately -20 plus 65 mesh and -65 plus 200 mesh and subjecting each size range separately to froth flotation, the finest range being floated with the reagent concentration materially less than that necessary for floating the whole range.

7. A method of floating phosphate rock which

comprises classifying the rock into at least two size ranges between 20 and 200 mesh, at least one sizing cut being in the range between about 48 mesh and 80 mesh and subjecting each range separately to froth flotation, the coarser ranges being floated with a reagent concentration not exceeding that necessary for floating the whole range and the finer ranges being floated with a reagent concentration materially less than that normally employed in floating the entire size range.

8. A method of floating phosphate rock which comprises classifying the rock into two size ranges approximately -20 plus 65 mesh and -65 plus 200 mesh and subjecting each size range separately to froth flotation, floating the coarsest range with a reagent concentration not exceeding that necessary for floating the whole size range and floating the finest range with a reagent concentration materially less than that normally employed in floating the entire size range.

9. A method of floating phosphate rock which comprises classifying the rock into three size ranges approximately -20 plus 35 mesh, -35 plus 65 mesh and -65 plus 200 mesh and subjecting each range separately to froth flotation.

10. A method of floating phosphate rock which comprises classifying the rock into three size ranges approximately -20 plus 35 mesh, -35 plus 65 mesh and -65 plus 200 mesh and subjecting each range separately to froth flotation, the finest range being floated with a reagent concentration materially less than necessary for floating the entire size range.

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