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CONCENTRATION OF NONMETALLIC MINERALS

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2 Claims. (Cl. 209—166)

The present invention relates in general to ore concentration, and more particularly to concentration of non-metallic minerals included in the group consisting of phosphates, barite and fluorspar.

The object of the invention is to provide for an improved process enabling the above-mentioned minerals to be expeditiously and effectively concentrated from their ores by flotation.

In accordance with the invention, a pulp of suitably divided particles of the ore containing the non-metallic mineral to undergo concentration is first conditioned by agitation with flotation agents hereinafter stated, and is thereafter heated sufficiently to cause air flocks of the non-metallic mineral particles to form, these flocks rising to the surface where they may be skimmed or floated off. This second operation may be carried on in any suitable open vessel instead of in a flotation machine, and has been found to yield excellent results with relation to both content and recovery of values in the floated material, these results being comparable in every way to those obtained by the usual procedure according to which the pulp is agitated and aerated in a flotation machine at normal temperatures.

The conditioning of the pulp is carried out with the aid of a substantially insoluble and unsaponifiable oil, together with a cooperating agent which causes an oiling of the non-metallic mineral particles by that oil preferentially to the particles of the gangue. As the cooperating agent many substances have been found useful, these including fatty acids and soaps of fatty acids, sulphonated fatty acids and soaps of sulphonated fatty acids, and naphthenic acids and soaps of naphthenic acids. Frequently, the substantially insoluble and unsaponifiable oil and the cooperating agent are employed with alkali and a frothing agent. If the cooperating agent is a fatty acid or fatty acid soap containing less than 13 carbon atoms, an activating agent in the form of a soluble salt of a metal should additionally be employed to render that acid or soap effective.

It is understood that the process of the invention is one of flotation within the modern meaning of the term, the reagents being employed in such small amounts that their effect of buoyancy on the non-metallic mineral particles is negligible.

To prepare the ore for treatment, it is usually subjected to a grinding operation and the ground ore is preferably classified to remove all particles except those more suitable for efficient operation. Ordinarily the over-size particles are separated by screening, the remaining material being then subjected to a desliming operation. The over-size material is usually reground, deslimed, and added to the deslimed undersize; or it may be reground, added to the undeslimed undersize, and this mixture then deslimed.

The following examples describe certain tests which have been made in carrying the invention into effect, the reagent amounts given in each referring to proportions figured on the basis of the dry weight tonnage (2000 pounds) of the material treated.

Example I.—Deslimed ore from Mulberry, Florida, consisting mainly of so-called bone phosphate of lime (tricalcium phosphate) and silica and of a particle size to pass through a screen of 35 meshes to the lineal inch, was made up with water to a pulp of about 70% solids. This pulp was agitated in an impeller-type mixer; and, during agitation, the silica tailing, was twice similarly retreated in the heating pan at a temperature of approximately the boiling point of the water, without further addition of reagents. The tailings of these cleaning operations were assayed separately and were found to constitute middlings which, in practice, would be returned to the heating pans wherein additional recovery of values would be obtained. The results are indicated in the following table:

	Percent weight	Percent assay		Percent recovery B. P. L.	Ratio
		B. P. L.	Ins.		
Feed	100.0	35.16	------	100.0	------
Concentrate	42.8	71.44	5.02	87.0	2.34
Middling #2	0.8	45.01	------	1.0	------
Middling #1	1.8	36.37	------	1.8	------
Tailing	54.6	6.58	------	10.2	------

Example II.—A sample of the same deslimed ore was processed in the same manner as indicated in the preceding example, except that agitation of the pulp in the mixer was carried out with 1 pound of caustic soda, 1 pound of lead nitrate, 8 pounds of fuel oil, 10 pounds of caprylic acid, and 0.14 pound of the kerosene-rosin solution. As in the preceding example, large air flocks carrying the phosphate values formed and rose to the surface upon treatment of the diluted pulp in the heating pan, again a temperature of approximately the boiling point of the water in the pulp being employed for this treatment, as

well as for the subsequent two cleaning operations. The results were as follows:

	Percent weight	Percent assay		Percent recovery B. P. L.	Ratio
		B. P. L.	Ins.		
Feed	100.0	34.89	------	100.0	------
Concentrate	36.7	71.34	6.32	75.0	2.73
Middling #2	1.8	57.17	------	3.0	------
Middling #1	2.0	30.24	------	3.3	------
Tailing	59.5	10.99	------	18.7	------

Example III.—Here 0.8 pound of caustic soda, 4 pounds of fuel oil, and 1 pound of sulphonated red oil were employed for conditioning a pulp of the same deslimed ore and of the same consistency as in the preceding examples, the period of agitation in the mixer subsequent to addition of the reagents being the same as before. The sulphonated red oil was obtained by treating 90 parts by weight of red oil (crude oleic acid) with 10 parts by weight of concentrated sulphuric acid (66° Baumé). Again, large air flocks carrying the phosphate values formed and rose to the surface upon treatment of the diluted pulp in the heating pan. Here the rougher concentrate obtained by this treatment was only once cleaned by retreatment in the heating pan. The procedures were otherwise the same as already indicated, both the treatment resulting in the production of the rougher concentrate and the following single cleaning operation being carried out at a temperature approximating the boiling point of the water in the pulp. The following results were obtained:

	Percent weight	Percent assay		Percent recovery B. P. L.	Ratio
		B. P. L.	Ins.		
Feed	100.0	28.12	------	100.0	------
Concentrate	33.5	73.65	4.74	87.7	3.0
Middling	3.7	35.72	------	4.7	------
Tailing	62.8	3.39	------	7.6	------

Example IV.—A pulp of the same deslimed ore and of the same consistency as before was conditioned in the mixer with 1 pound of caustic soda, 2 pounds of fuel oil, and 2 pounds of naphthenic acid, the period of agitation subsequent to addition of these reagents being again approximately two minutes. As before, treatment of the diluted pulp in the heating pan caused large air flocks carrying the phosphate values to form and rise to the surface. As in the next preceding example, the rougher concentrate thus obtained was only once cleaned by retreatment in the heating pan. Again a temperature of approximately the boiling point of the water in the pulp was employed for both the treatment resulting in the production of the rougher concentrate and the single cleaning operation. The following results were obtained:

	Percent weight	Percent assay		Percent recovery B. P. L.	Ratio
		B. P. L.	Ins.		
Feed	100.0	27.49	------	100.0	------
Concentrate	30.4	73.35	5.6	81.1	3.29
Middling	4.0	30.99	------	4.8	------
Tailing	65.6	5.47	------	13.1	------

Example V.—A high-grade barite ore from Cartersville, Georgia, was taken for the purpose of this example. A deslimed sample of this ore, consisting mainly of barite and silica and of a particle size to pass through a screen of 35 meshes to the lineal inch, was processed in the identical manner indicated in Example I, except that the reagent proportions were as follows: caustic soda 0.4 pound, fuel oil 2.98 pounds, fish acid 0.8 pound, and kerosene-rosin solution 0.14 pound. As before, large air flocks carrying the values formed and rose to the surface upon treatment of the diluted pulp in the heating pan, both this treatment and the subsequent two cleaning operations being again carried out at a temperature approximating the boiling point of the water in the pulp. The following results were obtained, middling #1 being of higher grade than middling #2 apparently because of the much larger quantity of material which dropped in the first cleaning operation:

	Percent weight	Percent assay		Percent recovery $BaSO_4$	Ratio
		$BaSO_4$	SiO_2		
Feed	100.0	91.62	5.82	100.0	------
Concentrate	79.3	95.61	2.21	82.7	1.26
Middling # 2	2.4	78.83	16.43	2.1	------
Middling # 1	9.9	84.97	11.77	9.2	------
Tailing	8.4	65.50	29.89	6.0	------

Example VI.—Here a synthetic mixture of approximately equal quantities of fluorspar and quartz, and of a particle size to pass through a screen of 28 meshes to the lineal inch, was prepared and deslimed, the deslimed mixture being made up with water to a pulp of about 70% solids. This pulp was conditioned in the mixer with 1.02 pounds of fuel oil, 0.26 pound of fish acid, and 0.14 pound of the kerosene-rosin solution heretofore described, the period of agitation subsequent to addition of the reagents being again about two minutes. In the same manner as before, the conditioned pulp was diluted and treated in the heating pan to approximately the boiling point of the water therein, and at this point large air flocks carrying the values formed and rose to the surface, where they were skimmed off. Upon removal of the tailing, this rougher concentrate was only once cleaned by retreatment in the heating pan, a temperature of approximately the boiling point of the water being also employed for this cleaning operation. The following results were obtained:

	Percent weight	Percent assay		Percent recovery CaF_2	Ratio
		CaF_2	SiO_2		
Feed	100.0	42.55	53.91	100.0	------
Concentrate	41.1	98.47	0.68	92.9	2.44
Middling	3.6	42.19	51.87	3.6	------
Tailing	55.3	2.77	93.59	3.5	------

Whereas in the examples heating of the conditioned pulp was carried out to approximately the boiling point of the water therein, it is understood that the invention is not limited to any specific temperature of treatment of the conditioned pulp, since the best and most economical temperature for any particular set of conditions can be readily determined in practice by simple experimentation. None of the procedures described in detail herein should be interpreted as limiting the invention, these procedures being capable of being modified in many ways without departing from its spirit.

What is claimed is:

1. A process of concentrating by flotation a non-metallic mineral included in the group consisting of phosphates, barite and fluorspar, which comprises agitating a pulp of suitably divided particles of the ore containing the non-metallic mineral, in the presence of a substantially insoluble and unsaponifiable oil and a cooperating agent causing an oiling of the non-metallic mineral particles by that oil preferentially to the particles of the gangue, heating the pulp sufficiently to cause air flocks of the non-metallic mineral particles to form and rise to the surface, and collecting the floated material, said oil and cooperating agent being employed in such small amounts that their effect of buoyancy on the non-metallic mineral particles is negligible.

2. A process of concentrating by flotation a non-metallic mineral included in the group consisting of phosphates, barite and fluorspar, which comprises agitating a thick pulp of suitably divided particles of the ore containing the non-metallic mineral, in the presence of a substantially insoluble and unsaponifiable oil and a cooperating agent causing an oiling of the non-metallic mineral particles by that oil preferentially to the particles of the gangue, diluting the pulp, heating the diluted pulp to approximately the boiling point of the water therein, and collecting the floated material, said oil and cooperating agent being employed in such small amounts that their effect of buoyancy on the non-metallic mineral particles is negligible.

FRANCIS X. TARTARON.

CERTIFICATE OF CORRECTION.

Patent No. 2,105,827. January 18, 1938.

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It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 1, second column, line 19, before "pulp" first occurrence, insert the word thick; and line 21, after "agitation," insert the following:

> the following agents were added thereto: 0.4 pound of caustic soda, 4.21 pounds of fuel oil, 0.77 pound of fish acid, and 0.14 pound of a frothing agent consisting of three parts of crude rosin residue dissolved in one part of kerosene oil. After addition of the reagents, the pulp was further agitated for about two minutes. The pulp thus conditioned was diluted and heated in a flat pan to approximately the boiling point of the water therein. At this point large air flocks carrying the phosphate values formed and rose to the surface, leaving the silica at the bottom of the pan. This floated material or concentrate was skimmed off and, upon removal of;

and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 22nd day of February, A. D. 1938.

Henry Van Arsdale,
Acting Commissioner of Patents.

(Seal)

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