Patented Sept. 8, 1942 2,295,459

UNITED STATES PATENT OFFICE

2,295,459

FLOTATION PROCESS

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No Drawing. Application March 20, 1940, Serial No. 325,011

7 Claims. (Cl. 209—166)

The present invention relates to froth flotation processes for the removal of negatively charged ore materials from ores and more particularly it relates to the removal of acidic silicious gangue from slimy ores containing it.

A recent development in the flotation art has been the discovery that certain surface active cation reagents could be employed to effect a separation of negatively charged materials such as acidic silicious gangue from the ore values by a froth flotation of such gangues. The Lenher U. S. Patent 2,132,902 describes a flotation process and discloses certain reagents which are stated to effectively float acidic silicious gangue. The silica promoters disclosed by Lenher include broadly the quaternary ammonium compounds containing in the positively charged surface active portion thereof an aliphatic hydrocarbon radical having from twelve to eighteen carbon atoms. Representative members of the group are compounds such as dimethylbenzyl phenyl ammonium chloride sulfonated in the benzyl ring, trimethyl octadecyl ammonium bromide, beta stearamidophenyl trimethylammonium methyl sulfate, octadecyl alpha picolinium bromide and dodecylamine hydrochloride. The Ralston U. S. Patent 2,168,849 discloses a second class of cation active reagents that are useful as promoters in silica flotation. The silica promoters disclosed by Ralston includes a number of aliphatic amines or their water soluble salts among which are compounds such as dioctyl amine, dioctyl amine acetate, didodecylamine, didodecylamine hydrochloride, dihexylamine, dihexylamine acetate, dihexadecylamine hydrochloride, dioctadecyl amine hydrochloride, butyl dodecyl amine, butyl octadecyl amine hydrochloride, hexyl dodecyl amine acetate, etc.

While the use of these cation active reagents as pointed out above has made possible the froth flotation of silicious material, there are nevertheless some serious disadvantages which accompany their use.

According to the present invention I have found that the effect of slimes on silica flotation is quite different in its nature from the effects obtained in the ordinary types of flotation. In the usual flotation practice it is quite common to remove a major portion of the slime by so-called desliming treatments and this is all that is necessary to avoid the difficulties which are encountered when large percentages of slime are present. In silica flotation, however, this procedure will not produce satisfactory results. The silica seems to be sensitive to minute amounts of slime, so slight as to have practically no effect on ordinary flotation procedures, and in order to get really effective silica flotation, it is necessary to remove the slimes never contemplated before, and this extraordinarily complete removal of slimes forms the essential feature of the present invention. The difference between a small amount of slime and practically no slime, is very striking and the advantages of the present invention are obtained with practically all of the so-called cationic active flotation reagents, that is to say, flotation reagents which unite loosely with the acidic gangue.

The present invention is not limited to the froth flotation of acidic silicious gangue from any particular kind of ore material and can be employed to improve the separation of silicious material from either slimy metalliferous ores or slimy non-metalliferous ores.

The most important field of silica flotation at the present time is presented by the Florida pebble phosphate ores containing slimes and finely divided silicious gangue. However, up to the present time the use of cationic reagents to effect a silica flotation has not been commercially feasible with these phosphate ores due to the fact that excess reagent cost resulted or the silica removal was not sufficiently complete.

When the improved process of the present invention is employed in the treatment of phosphate rock there is not only a reduction in cost but also increased phosphate recovery is obtained, and at the same time a much higher grade of concentrate is possible.

Broadly, the present invention is not limited to any particular method of completely desliming the ore material prior to the froth flotation operation. A suitable method for completely desliming the type of material used in the present invention is described in the co-pending application of Harry L. Mead and Ernest J. Maust, Serial No. 320,121, filed February 21, 1940. The method of complete desliming of the ore is not important so long as it results in the very complete desliming which is essential for obtaining

the improved results of which the present invention is capable. A completely deslimed ore in accordance with the present invention is one in which there is less than 1% slimes present and preferably contains less than 0.5% slime.

The invention will be described in more detail in conjunction with the following illustrative examples.

Example 1

The following tests were conducted on a Florida pebble phosphate flotation feed without complete desliming. The reagent used in test #1 was 2 lbs. per ton of a 50% aqueous paste of lauryl amine hydrochloride containing some other amines of higher and lower alcohols. In test #2, 2 lbs. per ton of a reagent consisting of lauryl amine free base and other higher and lower alcohol amines were used. The results of these tests are given below.

Test No.	Feed percent insol.	Conc. percent insol.	Middl. percent insol.	Tail percent insol.	Amount reagent lbs./ton
1	62.31	89.64	90.98	29.27	2.0
2	62.41	94.38	79.02	20.81	2.0

Example 2

The following flotation tests were carried out on the same phosphate flotation feed but in this instance the feed was completely deslimed at about 200 mesh and contained less than 0.5% of slimes. In all these tests the reagent consisted of lauryl amine free base with other higher and lower alcohol amines, being the same reagent as was employed in test #2 of Example 1.

Product	Percent weight	Assays		Recoveries		Amount reagent lbs./ton
		Percent B.P.L.	Percent silica	B.P.L.	SiO_2	
Feed	100.00	35.46	54.53	100.00	100.00	
Conc.	54.61	2.06	96.20	3.17	96.33	0.40
Middl.	1.71	18.02	75.47	0.87	2.37	0.20
Tail	43.68	77.90	1.62	95.96	1.30	

Time of float: Conc. 2½ min.; middl. 2 min. Percent solids, 25.

It is readily apparent in a comparison of the results of Examples 1 and 2 that the use of 2.0 pounds of the cationic promoter, which amount is a non-economical quantity in phosphate flotation, failed to produce a marketable grade of phosphate rock from the slime containing ore of Example 1, whereas only 0.20 pound of the same promoter produced a relatively high grade phosphate product from the completely deslimed ore in Example 2.

Example 3

The following tests were conducted on a sample of crude cement rock from the Valley Forge Cement Company. In this test the feed was not deslimed before flotation. The results obtained are given below.

	Percent weight	Assays			Distribution, percent		
		Percent $CaCO_3$	Percent Al_2O_3	Percent SiO_2	Ca CO_3	Al_2O_3	SiO_2
Conc.	45.75	52.86	8.68	26.84	36.28	73.27	73.74
Tailing	54.25	78.28	2.67	8.06	63.72	26.73	26.26
Feed	100.00	66.25	5.42	16.65	100.00	100.00	100.00

In the above test the promoter used was 0.26 lb. of a 15% aqueous solution of lauryl amine hydrochloride per ton of feed. The mica and quartz were floated away from the calcite.

Example 4

The following flotation test was conducted on the same crude cement rock as in the above test but in this test the feed was completely deslimed before flotation. 0.19 lb. per ton of feed of the same reagent as was used in Example 3 was employed, and the mica and quartz floated away from the calcite.

	Percent weight	Assays			Distribution, percent		
		Percent $CaCO_3$	Percent Al_2O_3	Percent SiO_2	$CaCO_3$	Al_2O_3	SiO_2
Concentrate	34.45	56.08	7.28	25.18	24.24	64.45	83.05
Tailing	65.55	92.09	2.11	2.70	75.76	35.55	16.95
Feed	100.00	79.68	3.89	10.44	100.00	100.00	100.00

Example 5

The following test was conducted on a fine undeslimed fraction of the same crude cement rock. The results of this test are given below.

	Percent weight	Assays			Distribution, percent		
		Percent $CaCO_3$	Percent Al_2O_3	Percent SiO_2	$CaCO_3$	Al_2O_3	SiO_2
Concentrate	6.75	56.75	8.30	24.94	5.49	8.33	12.89
Tailing	93.25	70.67	6.61	12.20	94.51	91.67	87.11
Feed	100.00	69.73	6.72	13.06	100.00	100.00	100.00

In the above test the promoter used was 0.33 lb. per ton of a 15% aqueous solution of lauryl amine hydrochloride.

In comparing the foregoing tests it is noted that as the flotation feed is more thoroughly deslimed the amount of promoter necessary is reduced, the grade of the calcite product (tailing) is increased and the silica recovery in the concentrate is increased.

Silica flotation tests were carried out on a partially deslimed phosphate rock in which quantities ranging from 0.9–2.0 pounds per ton of ore of various cationic reagents such as cetyl trimethyl ammonium bromide and benzyl phenyl dimethyl ammonium bromide were employed. The results obtained were very poor.

Test work on which the present specification is based indicated that the detrimental action of slime was primarily due to its effect on the silica rather than on the portion of the ore which was not to be floated. Accordingly some tests were made in which the non-floatable portion of the ore was eliminated in order to eliminate this possible variable factor. For example a mixture containing 600 parts of washed quartz and 5 parts of clay slimes, similar to those usually found in phosphate rock was subjected to a flotation operation in the presence of 0.5 lb. per ton of a reagent containing 50% aqueous paste of laurylamine hydrochloride with other amines of higher and lower alcohols. Even this small percentage of slimes (0.83%) completely killed the float and clearly demonstrates that 1% or more of slimes, on the dry basis of the ore, destroys the promoter action of cationic reagents. While the above results strongly indicate that the action of slimes is on the silica rather than on the non-floatable portion of the ore and while I believe that this is probably a true explanation of the action, nevertheless the flotation of sili-

cious material from non-metallic ores involves a fairly complex system and I do not wish to limit the present invention to the above theory which I advance only as being a very probable one.

The term "cation active reagents" has been used rather generally in the industry to cover flotation promoters which have active basic groups. The theory was propounded in the Lenher patent referred to above that the operation of this class of reagents depended on ionization of the flotation promoters and the presence of cations in the flotation pulp. It is not desired to limit the present invention to any particular theory of action and the term "cation active reagents" is used in the loose sense in which it is used in the trade. As a matter of fact from considerable evidence I am of the opinion that the theory in the Lenher patent is not universally true because good flotation of silica is obtainable under conditions which make ionization of the flotation reagent highly improbable. For this reason it is not intended that the term shall limit the present case to this theory of action and it is merely used to designate broadly a class of flotation reagents which have active basic groups capable of promoting the flotation of acidic minerals such as silica.

What I claim is:

1. A process of separating silicious matter from non-metallic ores by froth flotation which comprises subjecting a deslimed pulp of the ore containing not more than 1% of slimes to froth flotation in the presence of a cation active flotation collector for the silicious matter.

2. A process of separating silicious matter from phosphate rock by froth flotation which comprises subjecting a deslimed pulp of the ore containing not more than 1% of slimes to froth flotation in the presence of a cation active flotation collector for the silicious matter.

3. A process according to claim 2 in which the phosphate flotation feed contains not more than about .5% slimes.

4. A process according to claim 2 in which the cation active flotation reagent is an amine.

5. A process according to claim 2 in which the cation active flotation reagent is lauryl amine hydrochloride.

6. In a process of separating acidic silicious gangue from slimy ores containing the same by means of froth flotation in the presence of cationic reagents, the improvement which comprises the steps of desliming the flotation feed until it contains not more than about .5% slimes and subjecting said reslimed flotation feed to the froth flotation operation.

7. In a process of separating acidic silicious gangue from slimy phosphate rock containing the same by means of froth flotation in the presence of cationic active flotation reagents, the improvement which comprises the steps of desliming the flotation feed until it contains not more than about .5% slimes and subjecting said deslimed flotation feed to the froth flotation operation.

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