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3,278,028

FLOTATION OF MICA

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The invention herein described and claimed may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of royalties thereon or therefor.

This invention relates to beneficiation of mica ores by flotation.

Mica is widely used for insulation in electrical and electronic applications, in manufacture of paint, rubber goods, wall board, roofing material, in drilling muds, etc.

Mica ores normally occur in pegmatites associated with such minerals as quartz, feldspars, tourmaline, apatite, spodumene, beryl, kaolinite and limonite. Domestic production of scrap and flake mica used in producing ground mica is presently dependent almost entirely on crushing and screening and on gravity methods for recovering the mica. In the few cases where flotation is utilized, the ore must be thoroughly deslimed, usually at 100 mesh. These methods are inefficient and result in considerable losses of mica. Furthermore, the concentration of mica ores by flotation has presented many problems, not the least of which, is the production of slimes during conditioning and flotation.

It is therefore an object of the present invention to provide a simple and efficient flotation process for producing a high purity mica concentrate.

A further object of the invention is to provide a process for flotation of mica in the presence of slimes, with a minimum loss of mica.

A further object of the invention is to provide a process by which mica may be concentrated from associated gangue materials regardless of their varying proportions or surface alterations.

It has now been found that the above objects may be achieved by means of a process employing a combination of a cationic and an anionic reagent as a flotation agent and an alkaline inorganic material to retard flotation of the gangue materials.

Both cationic and anionic reagents have been used in flotation processes, including mica flotation. U.S. Patents 2,132,902 to Lenher and 2,885,078 to Fenske disclose the use of cationic reagents while Patent No. 2,303,962 to Tartaron et al. discloses anionic reagents. Alkaline inorganic materials have also been used in various flotation processes. However, as is well known, the art of flotation is a highly empirical one in which a wide variety of factors may have a substantial or even critical effect on the degree of separation attained. Such factors include the nature of the collector, the depressant, deflocculating agents, activators, pH, etc. Determination of the optimum combination of ingredients for separation of a particular material is largely unpredictable and can be determined only by extensive tests and experiments. As stated above, the combination of cationic and anionic reagent and the alkaline inorganic material, according to the present invention, has been found surprisingly effective in flotation of mica, particularly in the presence of slimes.

Coco amine acetate has been found to be particularly effective as the cationic reagent; however, other cationic reagents, such as those disclosed in the aforementioned patents to Lenher and Fenske, may be employed. Suitable anionic reagents are saturated or unsaturated amine acetates whose alkyl groups contain 8 to 22 carbon atoms.

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Other examples are octyl amine acetate, tallow amine acetate and soya amine acetate.

Oleic acid has been found to be highly effective as the anionic reagent; however, other anionic reagents such as those referred to in the above-mentioned patent to Tartaron et al. may be used. Suitable anionic reagents are saturated or unsaturated fatty acids containing 8 to 20 carbon atoms or salts thereof. Examples are linoleic acid, linolenic acid, stearic acid, palmitic, rosin acids (distilled tall oil) or mixtures of these acids.

The preferred alkaline inorganic reagent is soda ash; however, other reagents such as sodium hydroxide or sodium silicate may be substituted in whole or in part for the soda ash. The function of this alkaline material is to retard flotation of the gangue materials and control the pH of the pulp. The exact mechanism of this retarding action has not been definitely determined but its effectiveness may be due to removal and dispersion of slime coatings on the mineral surfaces.

The pH of the flotation medium should be alkaline with a range of about 8.0 to about 11.0 being most effective.

The quantities of the various reagents are not critical and may vary considerably with the type and amount of ore treated, state of sub-division of the ore, amount of water etc. Optimum quantities are best determined empirically. An excess of collecting agents tends to float additional gangue with the mica in the roughing operation, but the gangue may be retarded in subsequent cleaners.

The general procedure used in the process of the invention is a conventional froth flotation procedure in which the ore is first ground to relatively fine particles, water is added to form a pulp and the pulp is passed to a flotation cell where reagents are added and air is introduced.

The invention will be further illustrated, but is not intended to be limited, by the following examples. The high percentage of mica recovered by the process of the invention is apparent from the data given in the tables accompanying the examples.

Example 1

A sample of mica ore was obtained from an Alabama pegmatite deposit. Analysis indicated that ore contained approximately 17.2 percent mica. In addition to mica, the ore contained quartz, feldspar, limonite, and clay-like minerals.

In carrying out the flotation process according to this invention, the ore was first ground to a suitable size for conventional flotation methods. With the ore cited, grinding to 28-mesh yielded satisfactory liberation of the mica.

A 250-gram sample of the ore was wet ground to pass 28 mesh using a laboratory Abbe mill containing various size flint pebbles. The ground charge was then deslimed by decanting to remove part of the clay from the pulp. The pulp was then transferred to a small mechanical cell of standard design, and sufficient tap water added to give a pulp containing about 40 percent solids. The pulp was conditioned for 5 minutes with 2.0 pounds of soda ash per ton of ore, followed by 5-minute conditioning with 0.80 pound of oleic acid per ton of ore, and an additional 1-minute conditioning with 0.20 pound of coco amine acetate per ton of ore. The pulp was diluted to 20 percent solids with tap water. Air was allowed to enter the cell, resulting in the formation of a heavily mineralized froth. A rougher froth was collected for 7 minutes, whereupon flotation was complete. The rougher froth was triple-cleaned to further retard the gangue collected with the mica in the rougher operation.

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The cleaner tailing was treated with 0.25 pound of soda ash per ton of ore, 0.32 pound of oleic acid per ton of ore, and 0.04 pound of coco amine acetate per ton of ore. A scavenger concentrate was removed and cleaned twice to retard any gangue material that floated in the rougher operation. The combined primary and scavenger concentrates had an average analysis of 98.3 percent mica with a recovery of 81.3 percent of the total mica content. The results of the test were as follows:

TABLE 1

Product	Weight, percent	Analysis, percent mica	Distribution, percent mica
Mica concentrate.....	8.8	97.8	50.1
Mica scavenger concentrate.....	5.4	99.2	31.2
Composite concentrate.....	14.2	98.3	81.3
Middling.....	4.9	6.8	1.9
Tailing.....	73.6	3.7	15.9
Slimes.....	7.3	2.1	.9
Composite.....	100.0	17.2	100.0

Example 2

Example 2 was carried out using a procedure identical to that used in Example 1, except that 1.12 pounds per ton of ore of a mixture of oleic and linoleic acids was used to replace oleic acid. The use of the oleic and linoleic acid mixture in combination with the cationic collector enables production of approximately the same grade and recovery of mica as does the oleic acid-cationic mixture.

The results of the test were as follows:

TABLE 2

Product	Weight, percent	Analysis, percent mica	Distribution, percent mica
Mica concentrate.....	9.1	97.3	51.7
Mica scavenger concentrate.....	5.1	99.3	29.6
Composite concentrate.....	14.2	98.0	81.3
Middling.....	5.0	6.8	2.0
Tailing.....	73.5	3.7	15.9
Slimes.....	7.3	2.1	.8
Composite.....	100.0	17.1	100.0

Example 3

In Example 3 the procedure was identical to that in Example 1, except that 0.2 pound of sodium silicate per ton of ore was used in conjunction with 1.0 pound of soda ash to disperse the slimes. The use of sodium silicate enables a yield of mica concentrate of approximately the same grade and recovery as does the use of soda ash alone. The combined concentrates analyzed 96.9 percent mica, and accounted for 78.6 percent of the total mica content of the ore.

The results of the test were as follows:

TABLE 3

Product	Weight, percent	Analysis, percent mica	Distribution, percent mica
Mica concentrate.....	7.5	96.8	47.9
Mica scavenger concentrate.....	4.8	97.1	30.7
Composite concentrate.....	12.3	96.8	78.6
Middling.....	5.2	7.4	2.5
Tailing.....	75.2	3.6	17.9
Slimes.....	7.3	2.1	1.0
Composite.....	100.0	15.2	100.0

Example 4

In Example 4 the procedure was identical to that in Example 1, except that 2.0 pounds of caustic soda (sodium hydroxide) per ton of ore was utilized in place of soda ash. The use of sodium hydroxide enables a yield of mica concentrate of approximately the same purity and recovery as does the use of soda ash. The combined

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concentrates accounted for 79.6 percent of the total mica content of the ore and analyzed 97.6 percent mica.

The results of the test were as follows:

TABLE 4

Product	Weight, percent	Analysis, percent mica	Distribution, percent mica
Mica concentrate.....	7.4	97.7	48.7
Mica scavenger concentrate.....	4.7	97.5	30.9
Composite concentrate.....	12.1	97.6	79.6
Middling.....	5.8	8.2	3.2
Tailing.....	74.8	2.1	16.1
Slimes.....	7.3	14.8	1.1
Composite.....	100.0	14.8	100.0

Example 5

Example 5 is identical to Example 1, except that 2.0 pounds of sodium silicate per ton of ore were utilized in place of soda ash. The use of sodium silicate enables the yield of a mica concentrate of approximately the same purity and recovery as does the use of soda ash. The composite concentrate analyzed 96.3 percent mica and accounted for 79.7 percent of the total mica content.

The results of the test were as follows:

TABLE 5

Product	Weight, percent	Analysis, percent mica	Distribution, percent mica
Mica concentrate.....	19.1	96.7	74.9
Mica scavenger concentrate.....	1.3	91.1	4.8
Composite concentrate.....	20.4	96.3	79.7
Middling.....	7.4	30.9	9.3
Tailing.....	60.5	4.1	10.0
Slimes.....	11.7	2.1	1.0
Composite.....	100.0	24.7	100.0

Example 6

A sample of mica mill feed was obtained from Western Mica of Caroline, Inc., Kings Mountain, North Carolina. Analysis indicated that the ore contained about 27.5 percent mica. In addition to mica, the ore contained quartz, feldspar, limonite, and kaolinite.

A 500-gram sample of the ore was ground to pass 28 mesh in a laboratory Abbe mill. The ground charge was then partly deslimed by decanting to remove part of the clay. The pulp was transferred to a small mechanical flotation cell, and diluted to about 40 percent solids using tap water.

The pulp was conditioned for 5 minutes with 2.0 pounds of soda ash per ton of ore, then 5 minutes with 1.60 pounds per ton of ore of a mixture of oleic acid, linoleic acid, and rosin acids (distilled tall oil), and finally 1 minute with 0.25 pound of coco amine acetate per tone of ore. Sufficient tap water was added to dilute the pulp to about 20 percent solids. The pH of the diluted pulp was 9.8. Air was allowed to enter the cell, resulting in a heavily mineralized mica froth. A rougher froth was collected for 7 minutes at which time flotation was completed. The rougher froth was cleaned three times to further retard the gangue minerals collected with the froth in the rougher operation.

The cleaner tail was then conditioned with 0.4 pound of soda ash per ton of ore, 0.32 pound of distilled tall oil per ton of ore, and 0.04 pound of coco amine acetate per ton of ore. A scavenger concentrate was then removed. The scavenger concentrate was cleaned twice to further retard any gangue minerals collected with the froth in the rougher operation. The primary concentrate and the scavenger concentrate were combined to produce a concentrate analyzing 97.4 percent mica and accounting for 84.5 percent of the total mica content of the ore.

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The results of the test were as follows:

TABLE 6

Product	Weight, percent	Analysis, percent mica	Distribution, percent mica
Mica concentrate.....	15.1	97.8	55.7
Mica scavenger concentrate.....	7.9	96.7	28.8
Composite concentrate.....	23.0	97.4	84.5
Middling.....	11.4	23.7	10.2
Tailing.....	54.3	1.9	3.9
Slimes.....	11.3	3.3	1.4
Composite.....	100.0	26.5	100.0

Example 7

Example 7 was carried out using a procedure identical to that used in Example 6, except that 1.28 pounds per ton of ore of a mixture of oleic acid and linoleic acid was used to replace the mixture of oleic acid, linoleic acid, and rosin acids. The use of the mixture of oleic acid and linoleic acid gives about the same grade and recovery of mica as does a mixture of distilled tall oil and cationic collector.

The test results were as follows:

TABLE 7

Product	Weight, percent	Analysis, percent mica	Distribution, percent mica
Mica concentrate.....	15.2	99.2	54.8
Mica scavenger concentrate.....	7.8	97.0	27.5
Composite concentrate.....	23.0	98.5	82.3
Middling.....	11.2	31.8	13.0
Tailing.....	54.0	1.7	3.3
Slimes.....	11.3	3.3	1.4
Composite.....	100.0	27.5	100.0

Example 8

Example 8 was carried out using a procedure identical to that used in Example 6, except that 0.96 pound of oleic acid per ton of ore was substituted for the mixture of oleic acid, linoleic acid, and rosin acids. The use of oleic acid gives about the same grade and recovery of mica as does a mixture of distilled tall oil and cationic collector.

The results of the test were as follows:

TABLE 8

Product	Weight, percent	Analysis, percent mica	Distribution, percent mica
Mica concentrate.....	12.0	97.9	55.4
Mica scavenger concentrate.....	5.9	96.7	26.9
Composite concentrate.....	17.9	97.5	82.3
Middling.....	3.4	27.8	4.5
Tailing.....	67.4	3.6	11.4
Slimes.....	11.3	3.3	1.8
Composite.....	100.0	21.2	100.0

Example 9

A sample of tailings from spodumene laboratory flotation tests was obtained. The sample had previously been ground to pass 48 mesh and had been treated with lignin sulfonate, sodium fluoride, and oleic acid. No attempt was made to remove any reagents which still might be adhering to the mineral particles.

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A 250-gram sample of the tailings was transferred to a small mechanical cell and sufficient tap water added to give a pulp containing about 40 percent solids. The pulp was conditioned for 5 minutes with 2.0 pounds of soda ash per ton of ore, and 0.48 pound of a mixture of oleic acid, linoleic acid, and rosin acids at a pH of 9.2; 0.10 pound of coco amine acetate per ton of ore was then added and the pulp conditioned for an additional 1 minute. Sufficient tap water was then added to give a pulp containing 20 percent solids. Air was allowed to enter the cell, resulting in formation of a heavily mineralized mica froth. The froth was collected for 3 minutes at the end of which flotation was complete. The rougher concentrate was cleaned 3 times to further retard the gangue collected in the froth during the rougher operation. The resulting concentrate analyzed 94.7 percent mica and accounted for 86.7 percent of the total mica content.

The results of the test were as follows:

TABLE 9

Product	Weight, percent	Analysis, percent mica	Distribution, percent mica
Mica concentrate.....	6.6	94.7	86.7
Middling.....	7.4	3.7	3.8
Tailing.....	86.4	.8	9.5
Composite.....	100.0	7.2	100.0

What is claimed is:

1. A process for beneficiating mica ore comprising adding to an aqueous pulp of the ore in a flotation cell (1) an amount of alkaline inorganic reagent sufficient to raise the pH of the aqueous pulp to from 8 to 11, (2) a anionic reagent selected from the group consisting of oleic acid, linoleic acid, linolenic acid, stearic acid, palmitic acid, rosin acids and mixtures thereof, and (3) an amine acetate having an alkyl group containing from 8 to 22 carbon atoms, froth floating the ore, and collecting the mica containing froth.

2. The process of claim 1 in which the amine acetate is coco amine acetate.

3. The process of claim 2 wherein the anionic reagent is oleic acid.

4. The process of claim 1 wherein the inorganic reagent is selected from the group consisting of soda ash, sodium hydroxide and sodium silicate.

5. The process of claim 1 wherein the pulp is prepared from ore which is ground to about 28 mesh or finer.

References Cited by the Examiner

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