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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, and is a modification and improvement of patent application Ser. No. 320,576 of Frank W. Millsaps and James S. Browning, filed Oct. 31, 1963, now U.S. Patent No. 3,278,028. The improvement is based on the fact that the process described in this invention is more positive and selective in the flotation of high quality mica concentrates, and that the process enables a selective separation of muscovite mica and biotite mica.

Mica is widely used for insulation in electrical and electronic applications, in manufacture of paint, rubber goods, wallboard, 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 muscovite mica may be concentrated from biotite mica and 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 and a lignin sulfonate to disperse and 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 and lignin sulfonates 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 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 and lignin sulfonate, according to the present invention, has been found surprisingly effective in flotation of mica, particularly in the presence of slimes.

Tallow amine acetate has been found to be particularly effective as the cationic reagent; however, other cationic reagents, however, other cationic reagents, such as those disclosed in the aforementioned patents to Lenher and Fenske, may be employed. Suitable cationic reagents are saturated or unsaturated amine acetates whose alkyl groups contain 8 to 22 carbon atoms. Other examples are octyl amine acetate, Coco 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 acid, 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 lignin sulfonates that we prefer to utilize as a slime dispersant and gangue depressant are the calcium, magnesium, or sodium lignin sulfonates derived from the by-product of the sulfite process of papermaking, commonly known as "sulfite liquor." These liquors, separated as waste from the cellulose pulp, contain soluble salts of the lignin sulfonic acids resulting from the decomposition of the wood by the acid solutions used in the pulping process.

The mechanism of the retarding action of the lignin sulfonate in our method of mica flotation has not been definitely determined and this invention is not limited to any theory of action. It seems probable, however, that the lignin sulfonate coats the surfaces of the gangue minerals so as to prevent their attachment to the bubbles in froth flotation. It is assumed that the mica particles in the pulp exhibit less tendency than the gangue particles to become coated by the lignin sulfonate, and the mica particles are thus made floatable. The lignin sulfonates are effective slime dispersants and may aid flotation by assisting in proper 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 subdivision of the ore, amount of water etc. Optimum quantities are best determined empirically. In general, however, amounts of reagents, in pounds per ton of ore, will be approximately as follows: alkaline inorganic reagent, 0.5 to 4.0; lignin sulfonate, 0.5 to 4.0; cationic reagent, 0.1 to 0.5 and anionic reagent,

0.4 to 1.6. 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 the ore contained 22.4 percent mica. In addition, the ore contained quartz, feldspar, limonite and clay-like materials.

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 and 1.0 pound of calcium lignin sulfonate per ton of ore, followed by 5-minute conditioning with 0.80 pound of oleic acid per ton of ore, and an adidtional 1-minute conditioning with 0.40 pound of tallow 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 5 minutes, whereupon flotation was complete. The rougher froth was cleaned twice to further retard the gangue collected with the mica in the rougher operation. The finished concentrate had an average analysis of 99.5 percent mica with a recovery of 87.1 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	19.6	99.5	87.1
Middling	5.7	26.3	6.7
Tailing	58.9	1.8	4.7
Slimes	15.8	2.0	1.4
Composite	100.0	22.4	100.0

Example 2

A sample of mica ore was obtained from a North Carolina pegmatite. Analysis indicated that the ore contained about 10.1 percent mica. In addition to mica, the ore contained quartz, feldspar, limonite, and kaolinite.

A 250-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 and 1.0 pound of calcium lignin sulfonate per ton or 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 0.40 pound of tallow amine acetate per ton 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 5 minutes at which time flotation was completed. The rougher froth was cleaned twice to further retard the gangue minerals collected with the froth in the rougher operation.

The finished concentrate had an average analysis of 97.7 percent mica with a recovery 86.7 percent of the total mica content of the ore.

The results of the test were as follows:

TABLE 2

Product	Weight, percent	Analysis, percent mica	Distribution, percent mica
Mica concentrate	9.0	97.7	86.7
Middling	5.8	6.8	3.8
Tailing	74.0	1.0	7.3
Slimes	11.2	2.0	2.2
Composite	100.0	10.1	100.0

Example 3

A sample of mica ore was obtained from a North Carolina pegmatite deposit. Analysis indicated the ore contained 8.5 percent muscovite mica, and 1.5 percent biotite mica. In addition, the ore contained quartz, feldspar, and clay-like materials.

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 and sufficient tap water added to give a pulp containing about 40 percent solids. The pulp was conditioned for 3 minutes with 2.0 pounds of soda ash and 1.0 pound of calcium lignin sulfonate per ton of ore, followed by 3 minute conditioning with 0.8 pound of a mixture of oleic acid, linoleic acid, and rosin acids at a pH of 9.2; 0.40 pound of tallow amine acetate per ton of ore was then added and the pulp conditioned for an additional 1 minute. Sufficient tap 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 4 minutes at the end of which flotation was complete. The rougher concentrate was cleaned twice to further retard the gangue collected in the froth during the rougher operation. The resulting concentrate analyzed 94.8 percent muscovite mica and accounted for 77.1 percent of the total muscvite mica content. Over 93 percent of the biotite mica was retarded in middling, tailing and slimes. The results of the test were as follows:

TABLE 3

Product	Weight, percent	Analysis, percent mica		Distribution, percent mica	
		Muscovite	Biotite	Muscovite	Biotite
Mica concentrate	7.0	94.8	1.5	77.1	6.7
Middling	4.8	26.1	11.2	14.6	33.3
Tailing	71.4	1.0	1.0	8.3	46.7
Slimes	16.8	----------	1.0	----------	13.3
Composite	100.0	8.5	1.5	100.0	100.0

What is claimed is:

1. A process for beneficiating mica ore wherein the mica content of said ore is a member of the group consisting of predominantly muscovite mica and mixtures of muscovite mica and biotite mica by selective flotation of muscovite mica comprising adding to an aqueous pulp of the ore in a flotation cell (1) a depressant for the gangue materials in the ore comprising an alkaline inorganic reagent and a lignin sulfonate and (2) a collector for the mica comprising a combination of a cationic re-

agent and an anionic reagent selected from the group consisting of fatty acids, rosin acids and salts thereof and then froth floating the desired mica.

2. Process of claim 1 in which the pH of the pulp is from about 8.0 to about 11.0.

3. Process of claim 1 in which the cationic reagent is an amine acetate.

4. Process of claim 3 in which the amine actate is tallow amine acetate.

5. Process of claim 1 in which the anionic reagent is oleic acid.

6. Process of claim 1 in which the alkaline inorganic reagent is soda ash.

7. Process of claim 1 in which the lignin sulfonates are salts of metals from the group consisting of calcium, magnesium, and sodium.

8. Method of claim 1 in which the pulp is prepared from ore which is ground to about 28 mesh.

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