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BENEFICIATION OF ACIDIC MINERALS

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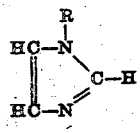
The present invention relates to mineral concentrations and more particularly relates to a new class of reagents for selectively separating acidic minerals from other ore constituents.

Still more particularly, the present invention relates to the use of higher alkyl derivatives of imidazole and salts thereof, as promoters or collectors for acidic minerals in froth flotation, film flotation, stratification, agglomeration, tabling and related mineral separation processes. While the present invention is not limited to any particular ore concentrating process utilizing differential surface wettability principles or to any particular ore, its most important field of usefulness is in connection with froth flotation processes of separating silica or silicate minerals, such as mica, from non-metallic ores such as limestone, bauxite, barytes, limenite, calcite, and the like, and especially phosphate minerals wherein the silicious gangue is floated away from the phosphate minerals.

In accordance with this invention natural ores or artificial materials comprising a mixture of acidic minerals with other mineral constituents are subjected to a separation or concentration process in the presence of a promoter for the acidic ore minerals, said promoter being a higher alkyl derivative of imidazole.

The reagents of the present invention are effective promoters or collectors for negatively charged or acidic ore materials generally and said acidic material may either be worthless gangue or valuable ore constituents. The most important uses are, however, in connection with the froth flotation of silica from non-metallic ores in which the silicious gangue may represent a minor proportion of the ore rather than metallic and sulfide ores in which the gangue usually represents the major proportion of the ore. Representative acidic ore materials are the feldspars, quartz, pyroxenes, the spinels, biotite, muscovite, clays, and the like.

The compounds which we have found to be useful in carrying out the present invention are the higher alkyl derivatives of imidazole and may be represented by the following general formula:



in which R represents a higher alkyl radical, that is to say, an alkyl radical containing from about 8 and usually not more than 30 carbon atoms.

The present invention is not particularly concerned with any method for preparing the alkyl derivatives of imidazole and any satisfactory method may be employed. They can be conveniently prepared by the reaction of an alkyl halide with imidazole, in which case the hydrohalide salts of the alkylated imidazole are obtained. The following preparation will serve to illustrate a process for preparing a representative compound.

A solution of 1 gram of imidazole and 2 grams of myristyl bromide in 50 cc. of anhydrous ethanol was boiled under a reflux condenser for 24 hours. The alcohol was then removed by evaporation on a steam bath. The product, the hydrobromide of N-myristyl imidazole, was a water soluble, cream-colored paste.

Instead of myristyl bromide we may use other alkylating agents such as octyl iodide, lauryl bromide, lauryl chloride, cetyl chlor-acetate, chlor-methyl myristyl ether, beta-chlor-ethyl palmitate, etc. It is clear, of course, that when monoalkylated derivatives of imidazole are prepared the alkylating agent must be one containing at least 8 but usually not more than 30 carbon atoms. Similarly, when desired, crude mixtures of the alkylating reagents may be employed.

Representative compounds that can be used in carrying out the present invention include the following: N-myristyl imidazole hydrobromide, N-ethyl-N'-lauryl imidazole hydrochloride, N-(lauroyl-beta-hydroxyethyl)-imidazole hydrochloride, N-lauryl imidazole hydrochloride.

We prefer to use these compounds in the form of their hydrohalide salts since they are either water soluble or readily dispersible in aqueous solutions. On the other hand, it is not necessary that they be used in the form of salts, and satisfactory results can be obtained using the free base providing that satisfactory dispersion and distribution is effected. When desired, salts other than the hydrohalide salts may be utilized, such as the nitrate, acetic, formate, propionate or other low molecular organic acid salts. Similarly, aromatic sulfonic acid salts may be employed such as, for example, benzene sulfonic acid or para-toluene sulfonic acid salts.

While, as stated heretofore, the present invention is not limited to the treatment of any particular ore material, it has been found to be well suited for froth flotation of silica from phosphate rock and is the preferred embodi-

ment of the invention. In the processes of removing silica from phosphate rock, the conditions are such that practically complete removal of the silica must be accomplished in order to produce a salable phosphate material. It is therefore an advantage of this invention that our reagents not only effect satisfactory removal of the silica but are also economical in amounts used. The quantities required range from 0.2 pound per ton of ore depending upon the particular ore and the particular reagent. The invention is not, however, limited to such quantities.

The reagents of the present invention may be used alone or in mixtures with other promoters. They may likewise be used in conjunction with other cooperating materials such as conditioning reagents, oily or fat materials such as hydrocarbon oils, fatty acids, or fatty acid esters.

These new reagents are also adaptable for use in any of the ordinary concentrating processes such as film flotation, tabling, and particularly in froth flotation operations. The ore concentrating processes employed will depend upon the particular type or kind of ore which is being processed. For example, in connection with phosphate rock, relatively coarse phosphate bearing material, for example 28 mesh and larger, can be very economically concentrated by using these reagents in conjunction with a material such as fuel oil or pine oil and subjecting to concentration by the use of tables or by film flotation. The −28 phosphate rock material is best concentrated by means of froth flotation employing these improved silica promoters.

When the reagents of the present invention are employed as promoters in the froth flotation of silica from phosphate rock, which is the preferred embodiment thereof, the condition may be varied in accordance with procedures known to those skilled in the art. The reagent may be employed in the form of aqueous solutions, emulsions, mixtures, or solutions in organic solvents, such as alcohol and the like. The reagent may be introduced into the ore pulp prior to the actual concentration operation. They may also be stage fed into the flotation circuit.

In its most important aspect the present invention is utilized for the treatment of non-metallic ore materials but it is to be understood that our reagents under proper conditions may be used advantageously for the treatment of metallic ore materials.

Other improved phosphate flotation features which are known may be utilized in connection with the present invention such as splitting the phosphate flotation feed into a plurality of size ranges and floating each size separately as described in the U. S. Patent No. 2,156,245, the very complete removal of the slime prior to flotation which is also an aid to better results as pointed out in the Erickson application, Serial No. 325,011 filed March 20, 1940, and the Mead and Maust application Serial No. 320,121 filed February 21, 1940, which describes a process for classifying and desliming phosphate flotation feed by means of a hindered settling classifier and which deslimed feed is well suited for treatment in accordance with this invention.

This invention will be further illustrated by the following specific test which illustrates a preferred embodiment thereof, but is not to be strictly limited thereby.

A flotation test as follows was made on a sample of Florida phosphate rock from the Old Colony Mine near Brewster. A fine flotation feed (−35 +200 mesh) was produced by scrubbing, polishing, and desliming until the ore material was substantially free of slimes.

A 600-gram sample of the deslimed flotation feed was diluted to 22% solids with water and transferred to a laboratory size Fagergren flotation machine. The particular reagent or reagent combination was then added and conditioned with the pulp for three seconds. Air was then admitted to the machine and the resulting concentrate froth was collected until the froth became barren. The flotation test product was then filtered, dried, weighed, and assayed. The metallurgical data obtained in the test are presented in the following table.

Table

Test No.	Feed Percent insol.	Concentrate			Tailing			Reagent	Lbs./ton of feed
		Percent wt.	Percent insol.	Dist. percent insol.	Percent wt.	Percent insol.	Dist. percent insol.		
1	54.54	55.21	90.76	91.88	44.79	9.90	8.12	Pine oil[1]	0.50 0.12

[1] N-myristol imidazole hydrobromide.

When rake classifier sands such as those produced from the tailings at the Valley Forge Cement Company plants are treated by flotation using our reagents, the alumina in the form of mica, is removed in part from the silicious material and a cement product is produced which has greatly improved properties.

In the treatment of iron ores we have found that our reagent may be employed in flotation processes for removing the silica therefrom and the tailings resulting from such processes are much higher in iron content than concentrates produced by the conventional soap flotation of the iron minerals.

What we claim is:

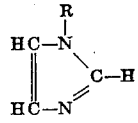
1. In the flotation process of separating acidic silicious gangue from phosphate ore values, the step which comprises subjecting the ore to froth flotation in the presence of N-myristyl imidazole hydrobromide.

2. In the flotation process of separating acidic silicious gangue from phosphate ore values, the step which comprises subjecting the ore to froth flotation in the presence of N-lauryl imidazole hydrochloride.

3. In the flotation process of separating acidic silicious gangue from phosphate ore values, the step which comprises subjecting the ore to froth flotation in the presence of N-(lauroyl-beta-hydroxyethyl) imidazole hydrochloride.

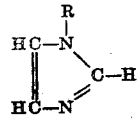
4. In a process of concentrating nonmetallic ore values from ores containing acidic silicious gangue, the step which comprises subjecting a

pulp of the ore to froth flotation in the presence of a collector adapted to selectively float a major portion of the acidic silicious gangue and selected from the group consisting of products represented by the formula:



where R represents a higher alkyl radical containing from about eight to thirty carbon atoms and the salts of such products.

5. In a process of concentrating phosphate ore values from ores containing acidic silicious gangue, the step which comprises subjecting a pulp of the ore to froth flotation in the presence of a collector adapted to selectively float a major portion of the acidic silicious gangue and selected from the group consisting of products represented by the formula:



where R represents a higher alkyl radical containing from about eight to thirty carbon atoms and the salts of such products.

6. In a process of concentrating phosphate ore values from ores containing acidic silicious gangue, the step which comprises subjecting a pulp of the ore to froth flotation in the presence of a collector for the acidic silicious gangue selected from the group consisting of N-myristyl imidazole and salts thereof.

7. In a process of concentrating phosphate ore values from ores containing acidic silicious gangue, the step which comprises subjecting a pulp of the ore to froth flotation in the presence of a collector for the acidic silicious gangue selected from the group consisting of N-lauryl imidazole and salts thereof.

8. In a process of concentrating phosphate ore values from ores containing acidic silicious gangue, the step which comprises subjecting a pulp of the ore to froth flotation in the presence of a collector for the acidic silicious gangue selected from the group consisting of N-(lauroyl-beta-hydroxyethyl) imidazole and salts thereof.

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