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FLOTATION OF BARITE

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This invention relates to the flotation of barite from its ores, and more particularly to a novel combination of flotation reagents exhibiting superior properties.

Barite, or native barium sulfate, is an important mineral, and its consumption has increased steadily throughout the world in recent years. Miners of this material have been forced to obtain barite from increasingly poorer ore bodies, with the result that flotation is used increasingly as a means of beneficiating the ore, so as to obtain a relatively pure barite. This is of particular importance in the preparation of barite for use in weighting drilling fluids such as are used in the drilling of oil and gas wells, for which use the barite must have a high specific gravity, and since it is in general the only mineral in a barite ore which at once has a high density and chemical inertness, it is necessary to produce a beneficiated barite of high purity, generally in excess of 90 percent by weight, before a product is obtained which meets commercial specifications for a drilling mud weighting material. The process of flotation is of course well-known, and need not be described in detail here. Reference may be made to standard texts on the subject, such as that by A. M. Gaudin entitled "Flotation," published by McGraw-Hill Book Co., New York, 1932.

It is known to float barite with the aid of fatty acid soaps as the flotation agent, used of course with auxiliary agents such as frothers, silicate depressants such as sodium silicate, water softeners, and the like. The use of fatty acids has a number of disadvantages, however, among which is the difficulty of removing the flotation agent from the final product, in order that a hydrophilic barite may be produced. Proposals have also been made to use the sodium salts of the half sulphuric acid esters of fatty alcohols as flotation agents for barite. Such proposals do not appear to have found commercial application, since the cost of the sulfate esters is substantially higher than that of the fatty acid soaps, and the results obtained were not justified by the additional cost. Additionally, the froth obtained is generally too brittle for satisfactory plant practice.

We have discovered that if in the froth flotation of barite from its ores a mixture of an alkyl half sulfate ester and a fatty acid, in certain weight ratios with respect to each other, and both in the form of their alkaline salts, is employed, unexpectedly superior results are obtained, in that the middling load carried by the flotation system is sharply reduced, the froth has excellent mechanical properties, and an over-all lessened consumption of flotation agent results. The ratio in which the two types of agent are used may be as high as 20:1 to as low as 1:2, for the weight of ester to the weight of fatty acid. We prefer to determine this weight ratio of the two components of our flotation agent mixture in the acid form of each, although it will be understood that for any given case, such as for example the use of a particular weight ratio of dodecyl sulfate ester and oleic acid, the corresponding weight ratio can readily be calculated for the sodium salts of each of these.

The half sulphuric acid esters of the fatty alcohols are well-known and commercially obtainable. The fatty alcohol from which the ester may be made may contain from 8 to 20 carbon atoms, and may be saturated or unsaturated. The same alcohol chain is of course present in the ester. The esters are obtainable either in the acid form or as alkali metal salts, generally the sodium salts. They are described in some detail on pages 53–66 of the book "Surface Active Agents" by Schwartz and Perry, New York, 1949. We have had particularly good results with sodium cetyl sulfate, in which of course the alkyl group is saturated and has 16 carbon atoms. Likewise especially useful are sodium dodecyl sulfate; sodium "lauryl" sulfate, made from the so-called lauryl alcohol representing a mixture of fatty alcohols as obtained from coconut oil; sodium n-octyl sulfate; sodium oleyl sulfate; and the sodium fatty alcohol sulfates obtained from the fatty alcohols derived, respectively, from corn oil fatty acids, and from the fatty acid fraction of tall oil. The twenty-carbon atom compound, sodium n-eicosyl sulfate, may likewise be used. All of these materials, whether mixtures of fatty chains or not, and whether saturated or unsaturated, or mixtures thereof, are termed "alkyl half sulfate esters" in the claims which follow.

For the fatty acid portion of our mixed flotation agent, we may use any readily available fatty acid or soap thereof, in which the carbon chains contain from 8 to 20 carbon atoms, and whether saturated or unsaturated. Corn oil fatty acids are suitable, as is tall oil fatty acid. Tall oil fatty acid is a well-defined commercial commodity, and consists of the fatty acid fraction of tall oil obtained by fractional distillation of the latter, with only minor amounts of rosin acids as impurities. Crude oleic acid may be used, as well as cottonseed fatty acid, soybean fatty acid, and coconut oil fatty acid. Arachic (eicosanoic) acid, and caprylic (octylic) acid are likewise suitable. These are termed simply "fatty acids" in the claims which follow, and the terms as used therein are to be understood as defined herein.

In general, the pH during flotation with our novel mixture will be in the region of from 9.5 to 11.0. Sodium silicate will generally be found necessary with most ores, and in general a small amount of frother, such as a mixture of alcohols of from 4 to 7 carbon atoms, may be used. In general, the ester and the fatty acid used, if not already in the form of sodium salt of each when purchased, will be converted to the sodium salt form by the use of caustic soda. It is to be understood, however, that other alkalis, such as caustic potassium, may be used, giving the corresponding potassium salts.

An example of the use of our novel flotation agent mixture will now be given:

EXAMPLE

The ore used in the tests was from a deposit in Arkansas. The ore is a replacement of shale by barite, and also contains calcite, silica, and some pyrite.

The tests were made in a continuous operation of grinding, classification, thickening, conditioning, and a roughing flotation, followed by three stages of cleaning. All middlings were returned to the rougher flotation feed for retreatment.

In all cases the flotation feed was maintained at 38% solids, and the pH regulated for optimum results in each instance. Sodium silicate was used as a dispersing reagent, and the flotation pulp temperature was held at 75–80° F.

During the continuous operation, check samples were taken, and adjustments made, until the entire circuit was in a balanced and optimum condition, at which time final samples were taken to establish the required data for each test.

The following tables give the results obtained for fatty acid alone, sodium cetyl sulfate alone, and a combination of the two.

The fatty acid used was obtained from tall oil, and contained oleic, linoleic, and linolenic acids in the relative proportions of 50:40:4 respectively, with about 6% residual rosin acids.

Table I

	Concentrate					Middlings			Tailings		
	Percent Weight Recovery of—		Percent $BaSO_4$	Metallurgical Recovery of—		Percent Weight of—		Percent $BaSO_4$	Percent Weight of—		Percent $BaSO_4$
	Flotation Feed	Mill Feed		Flotation Feed	Mill Feed	Flotation Feed	Mill Feed		Flotation Feed	Mill Feed	
Sodium Cetyl Sulfate	36.84	51.35	90.50	57.70	80.82	28.25	39.38	58.50	48.91	48.65	22.67
Fatty Acid	26.77	46.67	91.70	40.58	74.37	42.63	74.30	64.50	30.60	53.33	27.65
Combination of Sodium Cetyl Sulfate and Fatty Acid	41.58	53.65	90.50	66.03	82.99	22.50	29.04	61.77	35.92	46.35	21.46

Table II

REAGENT CONSUMPTION

	Pounds Per Ton of—	
	Feed	Concentrate
Sodium Cetyl Sulfate:		
Sodium Silicate	3.88	7.556
Caustic Soda	0.50	.974
Sodium Cetyl Sulfate	0.968	1.885
Fatty Acid:		
Sodium Silicate	3.630	7.778
Caustic Soda	0.604	1.294
Fatty Acid	0.726	1.556
Combination of Fatty Acid and Sodium Cetyl Sulfate:		
Sodium Silicate	4.290	7.996
Caustic Soda	0.572	1.066
Sodium Cetyl Sulfate	0.500	0.932
Fatty Acid	0.086	0.160

We claim:

1. In a froth flotation of barite from its ores, wherein an aqueous suspension of comminuted barite ore is agitated and aerated, the step which comprises carrying out said flotation in the presence of an alkali metal salt of an alkyl half sulfate ester having from 8 to 20 carbon atoms in the alkyl portion thereof, and of an alkali metal salt of a fatty acid having from 8 to 20 carbon atoms, said ester and said fatty acid being present in a weight ratio in the range of from 20:1 to 1:2, and said sulfate ester salt and said fatty acid salt constituting the flotation agent for said barite.

2. In the froth flotation of barite from its ores, wherein an aqueous suspension of comminuted barite ore is agitated and aerated, the step which comprises carrying out said flotation in the presence of the sodium salt of an alkyl half-sulfate ester having from 8 to 20 carbon atoms in the alkyl portion thereof, and of the sodium salt of a fatty acid having from 8 to 20 carbon atoms, said ester and said fatty acid being present in a weight ratio in the range of from 20:1 to 1:2, and said sulfate ester salt and said fatty acid salt constituting the flotation agent for said barite.

3. In the froth flotation of barite from its ores, wherein an aqueous suspension of comminuted barite ore is agitated and aerated, the step which comprises carrying out said flotation in the presence of the sodium salt of an alkyl half-sulfate ester having from 8 to 20 carbon atoms in the alkyl portion thereof, and of the sodium salt of tall oil fatty acids, said ester and said fatty acid being present in a weight ratio in the range of from 20:1 to 1:2, and said sulfate ester salt and said fatty acid salt constituting the flotation agent for said barite.

4. In the froth flotation of barite from its ores, wherein an aqueous suspension of comminuted barite ore is agitated and aerated, the step which comprises carrying out said flotation in the presence of the sodium salt of cetyl sulfate and of the sodium salt of tall oil fatty acid, said cetyl sulfate and said fatty acid being present in a weight ratio in the range of from 20:1 to 1:2, and said sulfate ester salt and said fatty acid salt constituting the flotation agent for said barite.

5. The process of claim 1 wherein the pH during flotation is maintained within the range of 9.5 to 11.0.

6. The process of claim 4 wherein the pH during flotation is maintained within the range of 9.5 to 11.0.

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