

1

3,122,500

FLOTATION OF BARITE

James T. Gullett, Malvern, Ark., and William A. Reddie, Houston, Tex., assignors to Magnet Cove Barium Corporation, Houston, Tex.

No Drawing. Filed Jan. 24, 1962, Ser. No. 168,531
8 Claims. (Cl. 209—166)

This invention relates to the flotation of barite from gangue contained in its ores and is particularly directed to a novel combination of collection agents which is highly efficient in carrying out this process.

The process of beneficiating ores by means of froth flotation is old and well known and has been applied to the beneficiation of a great many ores. Briefly, it may be considered a process wherein an ore is finely ground and the resulting fine material is suspended in water to form a fluid pulp, and the entire mass is agitated and aerated in the presence of a collector and a frothing agent to form a froth floating on the surface of the liquid. In a process of this type, the collector must be such that it attaches itself to the surface of the heavy mineral particles, thus giving the mineral particles a hydrocarbon-like surface layer, usually of monomolecular thickness, which is capable of adhering to air bubbles and carrying the heavy mineral upward into the froth where it may be skimmed off by any suitable skimming device. It is obvious that the collector used for the beneficiation of any particular ore must be highly selective, so as to form films upon the surface of the desired mineral only and not upon the gangue, thus floating only the mineral particles allowing the gangue to remain at the bottom of the liquid.

Barite, or native barium sulfate, is an important mineral with wide industrial applications. Many of the higher grade deposits of barite in the United States have been worked out and miners of this material have been forced to obtain more and more barite from increasingly poorer ore bodies with the result that froth flotation for the beneficiation of barite is becoming increasingly more necessary.

In one of the principal processes for beneficiation of barite ores, that is, the preparation of barite for use as a weighting material in the drilling of oil and gas wells, the barite product must have a very high specific gravity; and since the gangue is usually of much lower gravity than the barite, it must be well separated from the barite ore so that the barite sold for this purpose should have a specific gravity of 4.25 or more.

Collectors for use in the barite flotation process should not only be efficient and highly selective, but also should be easily removable from the barite. Fatty acid soaps and certain combinations of fatty acids have been used and have been found to be excellent collectors for use in this process. The fatty acids, however, are hard to remove after the flotation process has been completed; and removal must be substantially complete, otherwise the purified barite is not wettable by water and is unfit for drilling mud use. Both chemical and mechanical methods of removing fatty acid residues have been tried. Among these methods, drying at high temperature has proved to be most economical, but at temperatures in excess of 600° F. some reaction occurs with increase in proportion of soluble salts in the product. The presence of soluble salts in barite is highly objectionable in the drilling mud field.

2

Certain mixtures of fatty acids and long chain organic sulfates, such as cetyl sulfate and stearyl half sulfate, have been used and found to be excellent collecting materials, specific in their collecting action for barium sulfate and easily removable from the beneficiated mineral at temperatures sufficiently low to prevent excessive formation of soluble barium salts. These sulfates, however, are quite expensive in the quantities used; and it is always desirable to lower the cost of beneficiating any mineral. Also, these sulfates are pastes at ordinary temperatures and are difficult to dissolve in water, especially under winter conditions when the water is cold.

It is therefore one object of this invention to provide a novel mixture of collecting materials for use in a barite flotation process in which the materials used are readily available and cheap, and which are highly efficient when used together.

Another object is to provide a novel combination of materials for use as a collector in the barite flotation process which are highly selective for barite and are easily removable from the barite after separation from gangue.

Another object is to provide a novel combination of collector materials for use in the flotation of barite which eliminates or greatly reduces the quantity of frothing agent required.

Another object is to provide such novel mixture of materials which give exceptionally high yield of barite and are cheap enough to eliminate the desirability of heating process water during winter operations in order to reduce the quantity of reagents required.

Another object is to provide such mixture of materials in which the materials are liquid at ordinary room temperatures and are easily soluble in the coldest water.

Other objects, advantages and features will be apparent to one skilled in the art upon studying this specification and the appended claims.

In the process of the present invention, barite is separated from gangue in a finely divided ore by froth-flotation in the presence of a mixture of a sodium salt of sulfated dinonylphenol still bottoms adducted with ethylene oxide and a fatty acid having from 8 to 20 carbon atoms per molecule. The mixture of sulfated dinonylphenol still bottoms adduct and fatty acid serves as a highly efficient collector. This mixture not only is highly specific for barium sulfate to give a high purity product but is very easy to remove from the barite after separation in froth. Both materials are liquids and the mixture is easily soluble in water at all temperatures above the freezing point.

A mixture of the sulfated still bottoms adduct and fatty acid is fully equivalent in efficiency to the best collecting agents for barium sulfate known at present and is extremely easy to remove from the purified barite. The froth has excellent mechanical properties and very small quantities of the mixture of collecting agents are required. In addition, these materials are so cheap that the over-all cost of conducting the process is noticeably lowered and heating process water during winter operations to reduce consumption of reagents or to dissolve the required amounts of reagent in water is eliminated as economically undesirable, since the additional quantities required for winter operation are so small that their cost is less than that of heating the water.

The ratio of sulfated still bottoms adduct to fatty acids

may be anywhere in the range from 10:1 to 1:2, but is preferably in the range from about 2:1 to 1:2. The fatty acids are even cheaper than the sulfated still bottoms adduct and for economic reasons, it is preferred to use as large a proportion of the fatty acids to still bottoms adduct as can be utilized with good results.

The fatty acid portion of the collector may be any readily available fatty acid having from 8 to 20 carbon atoms per molecule and may be saturated or unsaturated. Preferably, the fatty acid component is a mixture of fatty acids such as are available on the market as fatty acids from coconut oil, fatty acids from cottonseed oil, crude oleic acid, fatty acids from corn oil or any of the other available mixtures of fatty acids in this carbon atom range. The preferred fatty acid product is a mixture of fatty acids distilled from tall oil. The commercial products containing these acids from tall oil ordinarily contain about 50 percent oleic acid, 40 percent linoleic acid, about 4 percent linolenic acid and have a residual rosin acid content of about 6 percent. In this mixture, the rosin acids do not interfere, and we have found that it not only is a highly efficient collector when used in conjunction with the sulfated still bottoms adduct but is very easily removable from the concentrated barite.

Preferably, the fatty acids may be added to the pulp as such rather than in the form of fatty acid soaps, but there will be at least some conversion of the acids to soaps in the pulp since the flotation of barite is usually conducted in the pH range from 8.0 to 12.0 or preferably in the pH range from about 9.5 to 11.0. An alkaline material, preferably sodium hydroxide, is used in quantity required to give a selected pH in the range described above. The quantity of such alkaline material used will vary somewhat depending upon the particular ore being beneficiated and the weather conditions. A slime dispersant, such as sodium silicate, also is used in conventional manner. Preferably, the sodium hydroxide and sodium silicate are added in a first conditioner in the flotation circuit, and the materials used as collecting agents are added in a second conditioner.

A suspension of the finely ground ore is introduced into a thickener and a conventional flocculant, as, for example, a mixture of high molecular weight polyacrylamides, is added in quantity sufficient to flocculate and thicken the pulp to a desired degree. The resulting thickened pulp is then passed to a first conditioner where an alkali hydroxide and the slime dispersant are added. The alkaline pulp then is passed to a second conditioning tank where the collecting agents of the present invention are added. The fatty acid material and the alkali salt of sulfated nonylphenol still bottoms adduct preferably are added separately to save a mixing step and for convenience in control, but they may be pre-mixed and added together if desired. The resulting suspension then is passed through a series of flotation cells where it is agitated and blown with a gas such as compressed air and barite is separated from gangue and is floated in resulting froth.

Normally, a frothing agent will be found unnecessary when the mixture of collecting agents of this invention is used, but occasionally under particularly adverse conditions a small amount of frothing agent may be necessary. When required, the frother may be a low molecular weight alcohol, as, for example, isopropyl alcohol, amyl alcohol, or a polypropylene glycol methyl ester marketed under the trade name "Dow-Froth." In actual plant operation, it has been found that it is usually unnecessary to use a frothing agent, but in about 5 percent of actual operating time when conditions were particularly adverse, a small amount of conventional frothing agent was necessary for best results.

It will be seen that the steps of the process just described are conventional except for the use of the particular collecting agents of the present invention which decrease the cost, eliminate the necessity for warming the water used under winter conditions, eliminate or decrease the quan-

tity of frother normally required by performing the functions of both collector and frother, and decrease the difficulty of dissolving the collector agent in water.

The still bottoms adduct used in preparing the sodium salt of the sulfated still bottoms adduct component of the mixture of flotation agents is prepared from a still bottoms derived from a phenol alkylation process. In a process of this type, phenol is alkylated with an alkene of desired length and configuration to yield predominantly the corresponding alkylphenol and dialkylphenol. In this reaction, products having higher boiling points than that of the dialkylphenol are formed also, and will be present in the still bottoms residue. The exact composition of these high boiling products is not known, but it is known that they are produced in the above-described phenol alkylation process.

It is customary to distill the reaction mixture resulting from the phenol alkylation reaction to recover an overhead product. The principal material recovered in the first part of the distillation will be monoalkylphenol although this may be preceded by small amounts of unreacted alkene or phenol or both. If the fractionation is stopped at this point, as it frequently is in commercial practice, the remaining still bottoms product will contain dialkylphenol, any monoalkylphenol which did not pass off overhead during the first part of the distillation and a residue of products having higher boiling points than that of the dialkylphenol. The relative proportions of these three components will vary with the efficiency of the alkylation process and of the fractional distillation.

Generally, these still bottoms are derived from processes for alkylating phenol with a polymerized alkene wherein the alkene polymerized contains a number of carbon atoms in the range from 2 to 4. The alkene reactant can be either a branched or straight chain hydrocarbon. Examples of this class are still bottoms derived from alkylation of phenol with butene, pentene, hexene, octene, nonene, dodecene, pentadecene, hexadecene, octadecene, etc. The preferred material, however, is still bottoms derived from a fractionation of nonylphenol described below.

In view of the foregoing, the term "alkylphenol still bottoms" will be used in this specification and claims to embrace all still bottoms from distillation processes for separating products resulting from alkylation of phenol with C_4 to C_{20} alkenes to produce one or both the corresponding monoalkylphenols or dialkylphenols as above disclosed where such still bottoms comprises a high boiling residue, either in a substantially pure form or mixed with from 0 to 5 parts of the corresponding dialkylphenol and/or with 0 to 10 parts of the corresponding monoalkylphenol, the residue in any case being present in the still bottoms in an amount of at least 5 percent of the total still bottoms, said residue having a boiling point or range higher than that of the corresponding dialkylphenol.

The still bottoms oxyethylene adduct is more efficient as a component of the barium sulfate collector than a similar adduct of either monoalkylphenol or dialkylphenol. Apparently, the high efficiency comes from the presence of high molecular weight materials in the still bottoms residue although these are of unknown composition.

A preferred method for the preparation of the alkyl phenol still bottoms adduct is to adduct the still bottoms from a process for producing nonylphenol with from 1.5 to 3.0, preferably about 2, parts of oxyethylene per part of still bottoms. A preferred still bottoms residue, which is commercially available at present, is derived as a by-product in the preparation of nonylphenol by the following process.

In this preparation, one common practice is to polymerize propylene to provide a nonene comprising a very high percentage of 9-carbon chain trimer of propylene. Other nonenes can be used if desired. The nonene is

reacted with phenol in the presence of a catalyst, such as sulfuric acid or boron trifluoride. A mixture of alkylated phenols results which is then distilled to produce an overhead product comprising relatively pure nonylphenol. The still bottoms from this fractionation comprises any portion of the nonylphenol not distilled over, dinonylphenol and a residue of higher boiling materials which may contain polymerized phenols, alkylates of phenols which are higher boiling than dinonylphenol, complex benzene compounds and the like.

It will be apparent that the amount of nonylphenol in the still bottoms will vary with the efficiency of the alkylation process and of the subsequent fractionation step. By suitable fractionation procedure, the nonylphenol can be completely removed, leaving the still bottoms comprising dinonylphenol and residue. With still further distillation, a part or all the dinonylphenol can be removed, leaving a still bottoms comprising a substantially pure residue. Such fractionation usually is conducted under a vacuum of about 10 to 20 mm. of mercury and at a fractionator head temperature of not less than 200° C., such temperature being determined by the boiling point of the fraction removed overhead.

The alkylate from the nonylphenol process should be fractionated until at least 50 percent of the nonylphenol produced is removed as an overhead, leaving the remainder as still bottoms. Stated numerically, the nonylphenol still bottoms can comprise the high boiling residue, either pure or mixed, for each part of residue with from 0 to 10 parts of dinonylphenol and/or with 0 to 5 parts of nonylphenol, the residue in any case being present in an amount of at least 5 weight percent of the total still bottoms. Either or both dinonylphenol or nonylphenol can be present with the residue.

One specific still bottoms found useful contained 30 percent nonylphenol, 50 percent dinonylphenol and 20 percent high boiling residue, and nonylphenol still bottoms commercially available ordinarily will contain from about 15 percent to about 30 percent of nonylphenol with the balance being made up of dinonylphenol and high boiling residue, the dinonylphenol comprising the major portion of the balance, with the residue varying from at least 5 up to 20 percent or more.

The reaction between the alkyl still bottoms and the ethylene oxide is well known to those skilled in the art, and commercial products of this reaction are readily available on the market. One product of this type is sold commercially under the designation "OX-153 1-2." It is a still bottoms from the above-described nonylphenol process and is adducted with 2 parts by weight of ethylene oxide per weight of still bottoms.

The still bottoms comprising the residue and the dinonylphenol, if any, and the diluent nonylphenol, if any, is then reacted with oxyethylene. The amount of oxyethylene so reacted should be in the range from about 1.5 to 3.0, preferably about 2, parts per weight of the still bottoms being adducted. Where the still bottoms is rich in residue, the amount of oxyethylene should be chosen from the higher portion of this range. Where it becomes richer in dinonylphenol or in nonylphenol, the amount may be chosen from a lower portion of the range.

The nonylphenol still bottoms is reacted with ethylene oxide in the following manner: The nonylphenol still bottoms is charged into a suitable reaction vessel and about 2 percent or a little less of an alkaline hydroxide is added. The reaction vessel is then thoroughly purged with natural gas or other inert gas suitable for removing air while the temperature is elevated to about 150° C. The addition of ethylene oxide to the reactor vessel is commenced at this temperature, and the reaction mixture is maintained in the temperature range from 150° to 160° C. until the entire quantity of ethylene oxide desired has been added. The reactor contents are then recycled for about two hours in this temperature range. At the

end of the reaction period, glacial acetic acid is added in quantity to neutralize the adduct.

In converting the intermediate product from the reaction described above to the sulfated material of the present invention, the ethoxylated nonylphenol still bottoms residue is charged into a suitable reaction vessel and the temperature is raised to about 95° C. with agitation and sulfamic acid is added in quantity to convert the adduct into a sulfated product. The temperature is elevated during the reaction to about 115° C., and the resulting mass of reaction products is permitted to cool to approximately 65° C. A solution of an alkali hydroxide, containing about 40 parts by weight of the hydroxide dissolved in about 150 parts by weight of water, is then added to the reaction mass, preferably in small increments. The rate of addition is controlled so that ammonia evolved can be released from the system without excessive foaming. After addition of about one-half of the caustic solution, there is evidence of gel formation with slow release of ammonia. At this point, approximately 60 parts by weight of methanol are added to the reaction mass to lower the viscosity and to permit continuing addition of the caustic solution. When all caustic has been added, about 30 parts by weight of methanol and 58 parts by weight of water are added and the temperature of the reaction mass is raised to about 75° to 80° C. to complete removal of ammonia.

While the above description of the reaction illustrates sulfamic acid in use as the sulfating agent, it will be obvious to those skilled in the art that any of the common sulfating agents, such as sulfuric acid, oleum, sulfur trioxide or chlorosulfonic acid, may be used instead of sulfamic acid; and minor changes in the above process can be made according to well known principles of conducting a sulfation reaction. In any case, the neutralized product is an alkalized salt of a sulfated adduct made by adducting the alkylphenol still bottoms with ethylene oxide. Sodium hydroxide is a preferred alkali hydroxide and the sodium salt is the preferred product.

In general, the manipulative steps of the present flotation process are very similar to those of the prior art except for the presence of the particular novel collector mixture used. A finely ground barite ore is pulped with water and is agitated and aerated, usually in the presence of about .8 to 4.0 pounds per ton of sodium silicate, sufficient sodium hydroxide to give a desired pulp pH which preferably is in the range from about 9.0 to 11.0 with an optimum of about 10.5, sufficient frothing agent to form the desired froth, and the collector, which is a mixture of fatty acid and the sodium salt of sulfated still bottoms adduct described above. While sodium hydroxide is the preferred material for control of pH, it is to be understood that other alkalis such as potassium hydroxide may be used.

The following examples illustrate typical results in conducting the flotation of barite in the presence of the novel mixture of collecting agents.

EXAMPLE I

Laboratory-scale tests were conducted on a barite ore from southwest Arkansas, containing, in addition to barite, calcite, some pyrite and silica. These tests were conducted in a series of pH ranges from 8.1, the natural pH of an aqueous pulp of this ore, up to 12.0. The increase in pH was attained by the addition in increased quantities of sodium hydroxide. In each of the tests recorded in the following table, 0.75 pound of sodium salt of sulfated nonylphenol still bottoms adducted with about twice its weight of ethylene oxide was used in connection with 1.5 pounds per ton of a fatty acid fraction distilled from tall oil containing approximately 50 percent oleic, 40 percent linoleic, 4 percent linolenic and

about 6 percent residual rosin acids as the collecting agent. The following results were obtained:

TEST NO. 4678—pH, 8.1—LBS. PER TON NaOH, 0.

	Percent wt. recovered	Sp. gr.	BaSO ₄ content of fraction	Percent BaSO ₄ recovered
Conc.-----	66.0	4.244	92.3	88.3
Mids.-----	11.7	3.217	35.2	6.2
Tails.-----	22.3	2.948	17.0	5.5

TEST NO. 4679—pH, 9.0—LBS. PER TON NaOH, 0.1

	Percent wt. recovered	Sp. gr.	BaSO ₄ content of fraction	Percent BaSO ₄ recovered
Conc.-----	66.0	4.255	92.7	89.8
Mids.-----	11.0	3.201	35.7	5.7
Tails.-----	23.0	2.941	16.5	5.5

TEST NO. 4680—pH, 9.5—LBS. PER TON NaOH, 0.2

	Percent wt. recovered	Sp. gr.	BaSO ₄ content of fraction	Percent BaSO ₄ recovered
Conc.-----	66.6	4.267	93.1	89.5
Mids.-----	10.5	3.191	34.3	5.2
Tails.-----	22.9	2.934	16.0	5.3

TEST NO. 4681—pH, 10.0—LBS. PER TON NaOH, 0.4

	Percent wt. recovered	Sp. gr.	BaSO ₄ content of fraction	Percent BaSO ₄ recovered
Conc.-----	67.8	4.255	92.7	61.4
Mids.-----	10.5	3.133	30.3	4.6
Tails.-----	21.7	3.898	12.8	4.0

TEST NO. 4682—pH, 10.5—LBS. PER TON NaOH, 0.6

	Percent wt. recovered	Sp. gr.	BaSO ₄ content of fraction	Percent BaSO ₄ recovered
Conc.-----	69.3	4.255	92.7	92.9
Mids.-----	10.2	3.077	26.5	3.9
Tails.-----	20.5	2.871	11.0	3.2

TEST NO. 4683—pH, 11.0—LBS. PER TON NaOH, 1.0

	Percent wt. recovered	Sp. gr.	BaSO ₄ content of fraction	Percent BaSO ₄ recovered
Conc.-----	69.5	4.233	91.9	93.7
Mids.-----	10.7	3.046	24.3	3.8
Tails.-----	19.8	2.844	8.7	2.3

TEST NO. 4684—pH, 11.5—LBS. PER TON NaOH, 1.7

	Percent wt. recovered	Sp. gr.	BaSO ₄ content of fraction	Percent BaSO ₄ recovered
Conc.-----	71.6	4.199	90.6	94.4
Mids.-----	12.7	3.007	21.4	3.9
Tails.-----	15.7	2.830	7.5	1.7

TEST NO. 4685—pH, 12.0—LBS. PER TON NaOH, 3.0

	Percent wt. recovered	Sp. gr.	BaSO ₄ content of fraction	Percent BaSO ₄ recovered
Conc.-----	75.2	4.134	88.1	95.8
Mids.-----	13.1	2.927	15.3	2.9
Tails.-----	11.7	2.830	7.5	1.3

It will be observed from the above results that barium sulfate recovery was excellent in all ranges from pH 8.1 to 12.0, ranging from 88.3% at pH 8.1 to 95.8% at pH 12.0. However, the purity of the concentrate increased with increasing pH from 8.1 up to a maximum at pH 9.5 and slowly decreased with increasing pH above that point. Thus, the preferred pH range for carrying out our process will be found in the range from about 9.0 to about 11.0, with an optimum pH of about 10.5, based upon total recovery and purity of the concentrated material.

EXAMPLE II

Full-plant-scale tests were conducted using the novel combination of collecting agents of the present invention, using the same type of southwest Arkansas barite ore used in the laboratory-scale experiments. This plant was operated on a 16-hour-per-day schedule for a period of two weeks. Each day was divided into two 8-hour shifts; and in the first week, the collecting agents of this invention were used during the first 8-hour shifts and a combination of cetyl-stearyl sulfate and fatty acids from tall oil was used during the second 8-hour shifts. During the second week, the shifts using the different combinations were reversed in order to balance out any stop and start variables which were present.

In one shift each week, the reagents used were 0.8

pound per ton of sodium hydroxide, giving the pulp a pH of 10.6, 0.79 pound per ton of sodium salt of sulfated adduct of nonylphenol still bottoms, and 0.44 pound per ton of a fatty acid fraction derived from the distillation of tall oil. During the other shift, the reagents used were 1.0 pound per ton of sodium hydroxide, giving the pulp a pH of 11.0, 1.41 pounds per ton of cetyl-stearyl sulfate, and 0.46 pound per ton of fatty acids derived from tall oil.

In each shift, identical quantities of sodium silicate and frothing agent were used. The cetyl-stearyl sulfate-fatty acid combination was used as a comparison collector material because it was believed that this mixture was the most efficient collector known at the time the tests were run. The following results were obtained:

RESULTS USING SODIUM SALT SULFATED ADDUCT OF NONYLPHENOL STILL BOTTOMS AND FATTY ACID

	Percent wt. recovered	BaSO ₄ content of fraction	Percent BaSO ₄ recovered	Sp. gr.
Feed.-----	100.0	68.1	-----	3.68
Conc.-----	65.4	92.7	89.0	4.25
Tails.-----	34.6	21.6	-----	3.01

RESULTS USING CETYL-STEARYL SULFATE AND FATTY ACID

	Percent wt. recovered	BaSO ₄ content of fraction	Percent BaSO ₄ recovered	Sp. gr.
Feed.-----	100.0	68.4	-----	3.69
Conc.-----	65.8	92.7	89.2	4.25
Tails.-----	34.2	21.6	-----	3.01

It will be noted from the above results that the efficiency of the flotation process using the sodium salt of sulfated adduct of nonylphenol still bottoms in combination with fatty acid was substantially identical with that of cetyl-stearyl sulfate and fatty acid. It was found that the novel combination of the present invention resulted in a barium sulfate concentrate from which the collecting material was very easily removed and that there was a noticeable decrease in reagent cost. In addition, the fact that the salt of the sulfated adduct of nonylphenol still bottoms is commercially available as a liquid resulted in decreased time required for solution of the reagents in water, and the solubility of the new combination of reagents is such that no heating of water is required for its solution.

From the foregoing, it will be seen that this invention is one well adapted to attain all of the ends and objects hereinabove set forth, together with other advantages which are obvious and which are inherent to the process and method.

It will be understood that certain features and subcombinations are of utility and may be employed without reference to other features and subcombinations. This is contemplated by and is within the scope of the claims.

The invention having been described, what is claimed is:

1. In a froth-flotation process for separating barite from gangue wherein a finely ground barite ore is suspended in water, the resulting pulp is agitated and aerated in the presence of a collecting agent, and barite is recovered from the froth, that improvement which comprises carrying out froth-flotation in the presence of a fatty acid having 8 to 20 carbon atoms per molecule and an alkali metal salt of a sulfated still bottoms adduct, made by adducting a still bottoms, derived from a process for alkylating phenol with a polymerized alkene, with from 1.5 to 3.0 times its weight of ethylene oxide, sulfating the adduct and neutralizing the resulting product with an alkali hydroxide, wherein the alkene polymerized contains from 2 to 4 carbon atoms.

2. In a froth-flotation process for separating barite from gangue wherein a finely ground barite ore is suspended in water, the resulting pulp is agitated and aerated in the presence of a collecting agent, and barite is recovered

ered from the froth, that improvement which comprises carrying out froth-flotation in the presence of a fatty acid having from 8 to 20 carbon atoms per molecule and an alkali metal salt of a sulfated adduct made by adducting nonylphenol still bottoms with about 1.5 to 3.0 times its weight of ethylene oxide, sulfating the adduct and neutralizing the product with an alkali hydroxide.

3. The process of claim 2 wherein the fatty acid component is a mixture of fatty acids distilled from tall oil.

4. The process of claim 2 wherein the salt of the sulfated nonylphenol still bottoms adduct and fatty acids are present in proportions of about 10:1 to about 1:2.

5. The process of claim 2 wherein the salt of the sulfated nonylphenol still bottoms adduct and fatty acids are present in proportions of about 2:1 to about 1:2.

6. The process of claim 1 conducted in the presence of an alkali metal hydroxide in quantity sufficient to give a pulp pH in the range from 9.0 to 11.0.

7. The process of claim 5 conducted in the presence of sufficient sodium hydroxide to give a pulp pH of about 10.5.

8. The process of claim 2 wherein the alkali metal salt of sulfated nonylphenol still bottoms is a sodium salt.

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