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FLOTATION PROCESS FOR OXIDIZED MANGANESE ORE

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The present invention relates to flotation processes and flotation reagents for use in the separation of minerals, with particular reference to the concentration of oxidized metallic ores, such as the oxidized ores of manganese.

It is an object of my invention to provide a flotation process which gives improved recoveries and higher grade concentrates, at lower costs of operation, in the flotation of oxidized metallic ores.

Another object of my invention is to provide flotation reagents which are cheaper and more easily prepared than any now known in the art.

Another object of the invention is to provide a flotation process which gives efficient recoveries of valuable ore concentrates in the treatment of highly refractory oxidized metallic ores, such as the oxidized ores of manganese that exhibit pronounced "sliming" characteristics when ground to a size permitting separation of the ore minerals from the gangue.

Further objects and advantages of the invention will become apparent from the following description.

It has heretofore been proposed to carry out the concentration of oxidized alkaline earth ores by flotation in the presence of a flotation reagent consisting of a soap or highly alkaline dispersion made from the mixture of fatty and resin acids, known as "talloel," that is recovered as a by-product in the manufacture of paper and pulp from resinous woods by the "kraft" or sulfate process.

According to this prior practice, purified talloel is either saponified with sodium hydroxide or other caustic agent and then added to a watery pulp of the ore, or the talloel is added to an ore pulp which has been made alkaline with a suitable caustic agent, thereby forming the soap "in situ," the amount of caustic being regulated to maintain a high degree of alkalinity in the pulp after the addition of the talloel.

A characteristic of these known procedures is the production of a voluminous froth which is extremely difficult to handle in the actual flotation process. The frothing characteristic of talloel soaps, or talloel in alkaline solutions, has imposed serious limitations on the application of talloel as a flotation agent for ores of diverse qualities.

This difficulty is especially marked when treating ores containing a gangue material that has been reduced to a fine state of division, or "slime" as known in the art, in the grinding operations which are necessary to free the ore materials from the gangue in order that a flotation separation may be effected. The tendency for talloel soap, or talloel in highly alkaline pulps, to give a voluminous tenacious froth is even more serious when both the ore and gangue materials have pronounced sliming characteristics. The low grade manganese ores of Eastern Cuba are a notable example of this type of ore. Sliming ores are especially hard to concentrate with talloel soap, or by the addition of talloel to highly alkaline pulps, because the slime, much of which may extend into the true colloidal range, tends to stabilize the froth. This tendency of slime to stabilize the froth is especially marked in pulps of high alkalinity. Stabilization of the froth lessens the chance for coarse gangue particles to fall back into the pulp; therefore, there is a lowering of the grade of the concentrate due to mechanical entrainment of gangue. Moreover, since the forces of surface tension are greater than the forces of gravity on extremely fine particles, all of the slime in the froth goes over with the ore minerals particles and entrained coarse gangue particles. The mechanical carry-over of both coarse gangue and slime produces a low grade concentrate which is difficult, and in many cases, impossible to clean to a grade that is marketable.

In order to minimize difficulties heretofore encountered in the flotation of sliming ores, it has been necessary to classify the ore pulps into selected sizes before the flotation treatment; in other words, pulps are used which have been subjected to some type of de-sliming process, such as by mechanical or hydraulic classification, or by simple decantation of fine material. Classification to any selected size range before flotation naturally increases the loss of valuable minerals in the fine sizes, and when both the ore and gangue minerals have a tendency to slime the losses make such treatment economically impractical.

It has also been proposed to use a neutral hydrocarbon oil, such as gas oil or fuel oil, along with talloel soap, etc., in an attempt to overcome the excessive froths produced with the known process and reagents. When treating a selectively sized flotation feed this expedient has met with some success, but with unclassified pulps, especially with ores containing slimy gangue, slimy ore minerals, or both, the use of the auxiliary hydrocarbon oils has been of little value; when employed to any appreciable advantage, a large quantity of oil is required.

According to the present invention, I have now found that I can successfully treat various types of oxidized metallic ores, regardless of the physical characteristics of the ore or gangue minerals, by employing a colloidal dispersion or emulsion of talloel in an ore pulp containing oxidized metallic minerals and gangue, keeping the pulp slightly acid, neutral, or with an alkalinity of not more than pH 7.4. Thus I have found it possible to obtain efficient flotation and concentration of valuable ore minerals, giving improved recoveries and a higher grade of concentrates, and these results may be obtained when treating pulps of diverse qualities without encountering the restrictive and costly requirements involved in the use of the known processes.

Moreover, I have found that the flotation process can be carried out successfully, in many cases, without requiring an auxiliary hydrocarbon oil, and in those cases where it is desirable to use such an oil the amount employed is only a small proportion of that used according to prior processes employing talloel.

Another important feature of my improved process is that any type of talloel can be used effectively, the gravity, acid number, iodine number, etc., being relatively unimportant. In other words, I have found that it is not necessary to use a purified talloel, the material produced by simple acidulation of crude black liquor soap being entirely suitable. The lignins, etc., present in this material simply act as harmless diluents.

Another important feature of my improved process and reagent is that they minimize the frothing characteristics of talloel, thus eliminating to a great degree the mechanical carry-over of coarse gangue and slime. Thus I am able to produce a product of suitable grade with a minimum of cleaning operations, from the most refractory ores, without the necessity of selectively sizing the flotation feed by classification, desliming or other mechanical treatment.

According to the present invention, oxidized metallic ores, such as oxidized ores of manganese, are subject to the usual coarse crushing operations to produce a size range suitable for further reduction in a rod or ball mill or other fine grinding mill. A dispersion of talloel in water, constituting the flotation reagent, is prepared by mixing the talloel and water in the presence of a small amount of emulsifying agent, which may be an added organic, neutral, oil-soluble or water-soluble material, or a material produced "in situ" by the addition of a small amount of an organic talloel-soluble base or an inorganic water-soluble base, depending upon the procedure selected for preparing the dispersion. The coarsely crushed ore is fed to a rod or ball mill operating in closed circuit with a mechanical classifier for returning insufficiently ground material to the mill. At the grinding mill water and the emulsified talloel reagent are added to the ore in the proper proportions. I have found that best results are secured when the water content is adjusted to such an amount that the solids represent from about 20 to 35% of the total mass of the pulp. I have further found that best results are secured when substantially all of the reagent is added to the materials before leaving the grinding mill; by substantially, I mean 85% or more. The remaining 15% or less may be fed in stages to the various cells in the "rougher" flotation circuit. The temperature of the water added to the ore, or of the resulting pulp, is of no importance when my reagent is used due to the fact that the reagent is liquid and can be readily proportioned or handled at any temperature encountered in ordinary practice.

In those cases where it is desirable to use a neutral hydrocarbon oil, such as gas oil, fuel oil and the like, the oil may be emulsified with the talloel, added to the grind separately, or fed in stages to the various flotation cells. I have found that especially good results are obtained where at least a part of the neutral hydrocarbon oil is fed to the cells in stages.

The properly prepared pulp from the fine grinding circuit is passed through a flotation cell or series of cells, preferably of the mechanical subaeration type, although the pneumatic type also gives good results. The ore minerals particles are levitated to the surface of the pulp by attachment to the air bubbles introduced into the pulp. The ore minerals become preferentially attached to the air bubbles due to the fact that the emulsified talloel reagent selectively coats the surfaces of the ore minerals with a water repellent, nonpolar film which has a greater affinity for the air than for water, the gangue minerals being entirely unaffected by the treatment. The mineral laden bubbles, or concentrate, is collected as a froth on the surface of the pulp; the gangue minerals, being unaffected by the presence of the emulsified talloel reagent, remain wetted by the water of the pulp, sink to the bottom of the cell and are withdrawn as the waste or tailings.

There are, of course, several cell combinations which may be used to effect the separation of ore minerals and gangue, as will be appreciated by persons skilled in the art. The usual practice is to treat the pulp in one or more cells to produce a tailing product and a concentrate contaminated with some low grade material. The concentrate from the first cell or group of cells is conducted to a second cell or group of cells where another separation is made, thus improving the grade of the concentrate. The tailings from the second flotation separation are generally recirculated through the grinding system to free any chatted gangue, or carried back to the first cell or group of cells where any suppressed high grade material is recovered. The number of cleaning operations may be repeated as many times as desired to produce a concentrate of the desired purity.

The use of a dispersion of talloel in a pulp having an alkalinity less than pH 7.4, according to my process, ensures complete contact of ore mineral particles with the flotation reagent. The efficiency of this contact could be increased only by complete solution of the talloel, since the reagents here involved have an average particle size of about 1 micron or less. In the practice of the present process, the cost of treating a given amount of ore is reduced due to the facts that the equipment necessary for the production of soap is eliminated and the caustic heretofore used for saponification or for producing an alkaline pulp is eliminated or reduced to a very small percentage of that employed in the prior process.

In order to indicate completely suitable manners of practicing the present invention, the following examples of the preparation of my improved flotation reagent are given by way of illustration.

EXAMPLE A

Two volumes of water and one volume of talloel and a quantity of ethylene glycol oleate amounting to ½% of the weight of the talloel are passed through a colloid mill or some other type of high speed mixer thereby producing a stable emulsion or dispersion of the talloel in water. The small quantity of ethylene glycol oleate serves as a stabilizing agent for the dispersion. Measurements of the particle size, after allowing the dispersion to stand for several hours, show the average diameter of the talloel globules to be about 1 micron. The stable dispersion of talloel so prepared may be proportioned to the grinding circuit, cells, etc., by means of any of the conventional reagent feeders well known to the art.

A good dispersion of talloel in water can also be prepared by simply agitating the proper quantity of talloel, water and emulsifying agent in an open tank with a mechanical stirrer or a steam jet.

Another modification of this procedure is to add the necessary amount of ethylene glycol oleate to the talloel, the two being miscible in all proportions. The mixture of talloel and emulsifying agent are simply proportioned out in conventional manner, mixed with a quantity of water, passed through an emulsifying machine and the resulting emulsion conducted to the grinding circuit, cells, etc. This procedure is a very simple one since the quantity of water used in making up the emulsion is not critical as it is in the previous case when the reagent is proportioned after emulsification.

In place of ethylene glycol oleate, other neutral, organic, oil-soluble emulsifying agents may be used; for example: diglycol stearate, glycerol monostearate, diglycol laurate, glycerol monorecinoleate, propylene glycol oleate, propylene glycol stearate, diglycol palmitate, propylene glycol monoricinoleate.

I have found that .25 to 2% of the emulsifying agent, in relation to the mass of talloel, is ample for the production of a suitable dispersion. The amount of emulsifying agent to be used, however, is not at all critical.

EXAMPLE B

A quantity of triethanol amine amounting to 5% of that which would be necessary theoretically to saponify the acid content of talloel, is dissolved in a portion of talloel, the two being miscible in all proportions. The mixture of talloel and triethanol amine is proportioned out, mixed with water and emulsified, using the same procedure as in Example A. The triethanol amine, in this case, combines with a small fraction of the talloel acids to produce the triethanol amine soaps, which in turn act as the emulsifying and stabilizing agents. Again, the amount of triethanol amine used is not critical—as little as 1% of that quantity which would be necessary to saponify the talloel acids produces a very finely dispersed, stable emulsion, the particle size of which average .5 micron. In place of triethanol amine, other talloel-soluble organic bases may be used, for example, triethyl sulphonium hydroxide, methanol amines, ethyl amines, methyl amines, morpholine, aromatic amines, etc.

EXAMPLE C

A quantity of sodium hydroxide, or other water soluble inorganic basic substances capable of forming a water soluble soap with the talloel acids, amounting to 4% of that which will theoretically saponify the acid content of the talloel, is dissolved in a portion of water. The water containing the caustic agent and the talloel are proportioned out in the proper ratio and passed through a high speed mixer or colloid mill, thereby producing a stable emulsion having an average particle size in the neighborhood of 1 micron. The small amount of soap formed by the interaction of the caustic agent with the talloel acids acts as the emulsifying and stabilizing agent. The emulsion so produced may be handled, or proportioned, in any type of equipment now used in the art. Again, the amount of caustic agent necessary to produce the desired effect is not critical. Amounts as low as 1% give excellent results; however, amounts above 5% raise the pH to an undesirable alkalinity. A few of the many caustic reagents which may be used in the preparation of emulsions of this type are as follows: sodium silicate, sodium carbonate, sodium hydroxide, potassium carbonate, and potassium hydroxide.

EXAMPLE D

A quantity of a water soluble organic emulsifying agent amounting to .1% of the total weight of talloel is dissolved in a portion of water. This solution of water and emulsifying agent is used to prepare a talloel emulsion, using the same procedure as in the previous examples. I have found that best results are secured when not more than .4% of these emulsifying agents are used, based upon the weight of talloel used. Amounts as low as .05% produce an emulsion having an average particle size in the neighborhood of 1 micron. A partial list of suitable emulsifying agents of this type includes the following: aliphatic sulphonic acids or their sodium salts, sulphate esters of fatty alcohols of their sodium salts, etc.

Should it be desired to use a neutral hydrocarbon oil such as gas oil, crude oil or fuel oil as a part of the emulsified reagent, the oil is simply mixed with the talloel in the proper proportion before emulsification. The presence of the neutral oil in no way affects the particle size or stability of the emulsions.

The advantages and utility of the present invention are clearly indicated by the results obtained in the practice of my process on low grade manganese ores of Eastern Cuba, which represent one of the most refractory types of oxidized metallic ores. These ores contain the various oxides of manganese together with impurities such as iron oxides, silica, calcium carbonate, hydrated silicates and the like. The ore minerals as well as the gangue minerals have pronounced sliming characteristics; for example, a grind which is sufficient to liberate the ore minerals will reduce the ore to such a degree of fineness that as much as 20 to 25% of a normal deflocculated pulp will be found remaining in suspension after settling for a period of two hours in a 1000 cc. graduate. The suspended material contains slimed ore materials as well as slimed gangue, as demonstrated by the following analysis.

	Per cent Mn
Heads	19.2
Material remaining in suspension after 4 hours	17.1
Material settled out after 4 hours	20.0

This analysis further indicates that this type of ore would not lend itself to any de-sliming operation as ordinarily practiced, since the losses incurred by de-sliming or selectively sizing such a pulp before flotation would be prohibitive. It is apparent, therefore that any process or reagent to be used in treating this type of ore must be capable of effecting an efficient separation between ore and gangue particles in all degrees of fineness.

The following examples are given to illustrate the practice of my process in the treatment of low grade manganese ores of the type mentioned above.

EXAMPLE #1

An emulsion of crude talloel in water was prepared by passing through a colloid mill one volume of talloel and two volumes of water, in which sufficient sodium hydroxide had been dissolved to saponify 2% of the total acid content of the talloel. The resulting stable dispersion had an average particle size of about 1 micron. An amount of this emulsion equivalent to 10# of talloel per ton of feed was added to an ore charge in a rod mill, together with gas oil amounting to 5# per ton of ore and sufficient water to give a pulp having a solid content of 25%. The ore was then ground to such a fineness that 85% of the resulting pulp passed through a 100 mesh screen. The prepared pulp, which had a pH of 7.1, was placed in a mechanical, sub-aeration type flotation machine. A froth containing the valuable minerals was taken off at the top of the machine, and the worthless gangue or tailings was removed from the bottom of the machine. The first concentrate, or "rougher" concentrate, was then subjected to a second flotation after the addition of a small amount of an acidic "cleaning" agent, such as carbonic acid, sulphuric acid and the like. The amount of cleaning agent used is generally in the neighborhood of ¼–½# per ton. We have found, however, that in mill practice the use of cleaning agents can be omitted entirely.

The results of this example are shown in Table I.

Table I

	Wt.	Mn	Dist.	Recovery
	Percent	*Percent*	*Percent*	*Percent*
Feed	100.0	20.5	100.0	
Final tailings	35.3	7.4	18.3	
Cleaner concentrate	22.4	45.0	32.4	81.7
Cleaner tails	25.1	26.4	49.3	

The cleaner concentrate, after the usual sintering or nodulizing operation, which is necessary for the production of a material suitable for blast furnace feed, analyzed over 52% Mn—in other words, equal to or better than the highest grade of imported or domestic manganese ores.

For the purpose of comparing the efficiency of my process with the prior practice, a sample of the same ore was ground in the rod mill with sufficient water to give a pulp containing 65–70% solids. The pulp was made alkaline with 2.0# of sodium hydroxide, and, after mixing the caustic soda thoroughly with the pulp, the equivalent of 5# per ton of gas oil was added. Finally, crude talloel in an amount equivalent to 10# per ton was added to and thoroughly incorporated into the pulp. The treated pulp, which has a pH of 9.3 was then subjected to flotation in the same cell used in the above example of my invention. The result was the formation of a voluminous, tenacious wild froth that could not be controlled and which only diminished after practically all the ore charge had been carried over into the concentrate; in other words, no economic separation was affected.

EXAMPLE #2

An emulsion of crude talloel in water was prepared by dissolving in a volume of talloel sufficient triethanol amine to saponify 3% of the acid content of the talloel. The combination of talloel and triethanol amine was mixed with two volumes of water and passed through a high speed mixer, whereby a stable emulsion was formed. The average particle size of the emulsion was about .5–.75 microns. A volume of this emulsion equivalent to 10# of talloel per ton of feed was added to a charge of low grade manganese ore in a rod mill, together with sufficient water to give a pulp having a solids content of about 30%. No auxiliary neutral hydrocarbon oil was used in this test. The ore charge was ground and treated in accordance with the method described in Example #1. The pH of the prepared pulp was found to be 7.05.

The results of this example are indicated in Table II.

Table II

	Wt.	Mn	Dist.	Recovery
	Percent	*Percent*	*Percent*	*Percent*
Feed	100.0	20.2	100.0	
Final tailings		6.7	12.3	
Cleaner tailings		18.9	34.4	87.7
Cleaner concentrate		43.2	53.3	

After sintering, the cleaner concentrate produced a product running over 50% manganese, an exceptionally high grade product suitable for the production of ferro-manganese.

EXAMPLE #3

An emulsion of crude talloel in water was prepared by passing through a colloid machine one volume of talloel and two volumes of water in which was dissolved .1%, based upon the weight of talloel used, of a hydrocarbon sulphonate. The average particle size of the resulting stable emulsion was found to average less than 1 micron in diameter. A volume of emulsion equivalent to 10# per ton of feed was added to a charge of low grade manganese ore in a rod mill, together with sufficient water to give the ground pump a solids content of 25%. The ore was then ground to such a fineness that 85% of the resulting pulp passed through a 100 mesh screen. The prepared pulp, which had a pH of 6.95, was placed in a mechanical, sub-aeration type flotation machine. An amount of gas oil equivalent to 5# per ton of ore feed was added in stages throughout the flotation. A froth containing the valuable minerals was taken off at the top of the cell, and the worthless gangue or tailings was removed from the bottom of the machine.

The results of this test are indicated in Table III.

Table III

	Wt.	Mn	Dist.	Recovery
	Percent	*Percent*	*Percent*	*Percent*
Feed	100.0	31.5	100.0	
Final tailings	37.5	7.7	9.5	
Concentrate	62.5	44.1	90.5	90.5

In this case it was not necessary to clean the first concentrate in order to produce a product which, on sintering, would have a grade in the neighborhood of 53% or, in other words, a grade suitable for the production of ferro-manganese.

EXAMPLE #4

An emulsion of crude talloel in water was prepared by passing through a colloid machine three volumes of water and one volume of talloel in which was dissolved 1% by weight of propylene glycol oleate, an oil-soluble emulsifying agent. The stable emulsion formed in this manner had an average particle size of less than 1 micron. A volume of this emulsion equivalent to 8# per ton of feed was added to a charge of low grade manganese ore in a rod mill, together with sufficient water to give the ground pulp a solids content of 35%. The ore was then ground to such a fineness that 85% of the resulting pulp passed through a 100 mesh screen. The prepared pulp, which was found to have a pH of 7.1, was placed in a flotation machine of the same type used in the previous examples, and the flotation was carried out in the same manner as described in Example #1. In this example, however, the equivalent of 5#/ton of gas oil was fed to the cell during the "rougher" operation. The results obtained in this example are set forth in Table IV.

Table IV

	Wt.	Mn	Dist.	Recovery
	Percent	*Percent*	*Percent*	*Percent*
Feed	100.0	10.9	100.0	
Final tailings	77.6	3.5	25.0	
Cleaner concentrate	17.7	43.6	70.6	75.0
Cleaner tailings	4.6	10.5	4.4	

For purposes of comparing this process with the process of the prior art, a sample of the same ore was ground in a rod mill, to the same fineness as used in the above example, with sufficient water to produce a pulp containing 70% solids. To the ground pulp the equivalent of 8#/ton of a crude talloel soap and 5#/ton of gas oil were added and thoroughly incorporated into the pulp. The talloel soap was prepared by carefully saponifying talloel, in the well known manner, with the proper quantity of sodium hydroxide to give a pulp having an alkalinity of about pH 9.1. The treated pulp was then subjected to flotation in the same cell used in the above example of my invention. The result was the formation of an extremely voluminous, tenacious froth that could not be controlled, and the test had to be discontinued.

The advantages of the present invention may be summarized as follows:

Ores of various types can be successfully treated regardless of the physical characteristics of the minerals, without the necessity of sizing or classifying the pulp to remove the undesirable slime material. By operating at a pH less than 7.4 much of the undesirable frothing which is characteristic of talloel reagents is eliminated; thus I am able to produce a product of commercial grade with the minimum of cleaning operations. Any type of talloel may be used, the crude material being just as effective as the purified products per unit of acid content. By use of my dispersed reagent intimate contact between ore minerals and reagent is assured, thereby increasing the efficiency of the flotation process. The cost of concentrating a given ore is reduced when my reagent is used due to the facts that no losses are incurred by a selective "sizing" operation, the cheapest grades of talloel may be used, little or no caustic or other alkalizing or saponifying agent need be used, etc. My reagent is easy to prepare, is more stable and more easily proportioned in all types of equipment under more diversified temperature conditions. The use of an auxiliary hydrocarbon is eliminated or reduced to a minimum.

It should be understood that the present invention is in no way limited to the specific emulsifying agents or procedural steps given; variations may be resorted to, as anyone skilled in the art will readily understand.

I claim:

1. The process of concentrating oxidized manganese ore which comprises grinding the ore, combining the ore with an aqueous dispersion of talloel and producing watery pulp having a pH of not more than 7.4, subjecting said pulp to a flotation operation to form a froth containing ore minerals, and collecting said froth.

2. The process of concentrating oxidized manganese ore which comprises crushing the ore to condition the same for fine grinding, preparing an aqueous dispersion of crude talloel, grinding the ore, combining the ore during the grinding operation with said dispersion and water to produce watery pulp having a pH of not more than 7.4, subjecting said pulp to a flotation operation to form a froth containing ore minerals, and collecting said froth.

3. The process of concentrating oxidized manganese ore which comprises grinding the ore, contacting the ore during the grinding operation with water and an aqueous dispersion of crude talloel having an average particle size not substantially in excess of 1 micron, thereby producing watery pulp having a pH of not more than 7.4 and a solids content of about 20 to 35%, subjecting said pulp to a flotation operation to form a froth containing ore minerals, and collecting said froth.

4. The process of concentrating oxidized manganese ore which comprises subjecting to a flotation operation finely-ground watery pulp containing the ore in intimate admixture with an aqueous dispersion of talloel, said pulp having a pH of not more than 7.4.

5. The process of concentrating oxidized manganese ore which comprises subjecting to a flotation operation finely-ground watery pulp containing the ore in intimate admixture with an aqueous dispersion of crude talloel, said pulp having a pH of not more than 7.4 and a solids content of about 20 to 35 per cent.

6. The process of concentrating oxidized manganese ore which comprises grinding the ore, combining the ore during the grinding operation with an aqueous dispersion of talloel and producing watery pulp having a pH of not more than 7.4, subjecting said pulp to a flotation operation to form a froth containing ore minerals, and collecting said froth.

7. The process of concentrating oxidized manganese ore which comprises forming an aqueous dispersion of crude talloel, grinding the ore, combining the ore with said dispersion during the grinding operation and producing watery pulp having a pH of not more than 7.4 and a solids content of about 20–35 per cent., subjecting said pulp to a flotation operation to form a froth containing ore minerals, and collecting said froth.

8. The process of concentrating oxidized manganese ore which comprises grinding the ore, combining the ore with water and an aqueous dispersion of talloel in proportions forming watery pulp containing about 20 to 35% of solids, said pulp having a pH of not more than 7.4, contacting the ore with substantially all of said dis-

persion during the grinding operation, subjecting said pulp to a flotation operation to form a froth containing ore minerals, and collecting said froth.

9. The process of concentrating oxidized manganese ore which comprises grinding the ore, combining the ore during the grinding operation with an aqueous dispersion of talloel having an average particle size not substantially in excess of 1 micron and producing watery pulp having a pH of not more than 7.4, subjecting said pulp to a flotation operation to form a froth containing ore minerals, and collecting said froth.

10. The process of concentrating oxidized manganese ore which comprises combining the ore in ground form with an aqueous dispersion of talloel present for the most part in its acid or unneutralized form, forming a watery pulp having a pH value of not more than 7.4, producing a froth containing the ore minerals and collecting said froth.

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