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DEPRESSION OF NONCARBONACEOUS
MATERIAL DURING FLOTATION

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This invention relates to froth flotation, and more particularly to improvement in the flotation of noncarbonaceous ores having finely divided gangue.

5 Many ores have finely divided gangue or a portion of the gangue in a finely divided or slimy condition which frequently creates difficulties by reason of contamination of the concentrate by the fine gangue or by the action of the fine
10 gangue on the mineral values, preventing their ready flotation and thus reducing recoveries. In many cases, both factors are involved.

In the past, starch and other organic protective colloids have commonly been used for the
15 depression of gangue during flotation. However, these frequently cause the depression of certain of the desired constituents of the ore as well as the gangue and hence decrease recoveries.

According to the present invention, I have
20 found that froth flotation of noncarbonaceous ores is improved when it is carried out in the presence of dextrines which efficiently depress gangue without excessive depression of metal
25 values when used in amounts sufficient to give effective gangue depression. This result is surprising because while the prior art teaches the use of organic protective colloids as flotation agents, the dextrines of the present invention are very poor protective colloids. In fact, they can
30 hardly be called protective colloids at all, and yet they are better gangue modifiers than most good protective colloids.

The term "dextrine" is frequently loosely applied in the industry to cover a large number
35 of degraded cellulosic products. According to the present invention, however, dextrine is used in its strict sense as covering the products obtained by substantially dry heat degradation of cellulosic material such as starch with or without preliminary treatment with material such as
40 acids. The term "dextrine" will be used in no other sense in the present application and is not intended to include materials obtained by digesting starch in various aqueous solutions which
45 are sometimes loosely referred to as dextrinized products. These latter products do not exhibit the properties of true dextrines in the flotation of ores and are not included in the scope of my invention.

50 While all true dextrines show the valuable properties set out above, different dextrines will vary in the degree to which they possess these properties and in general, the best results are obtained with yellow corn dextrines which result
55 from the dry heating of corn starches which have

been pre-treated with acids such as nitric acid.

The amounts of dextrine required will vary to some extent with the ore and with the dextrine. In all cases, it is necessary to use sufficient amounts of dextrine to effectively depress
5 the gangue, but the amount should not be large enough to seriously depress metal values. To some extent, this may be considered as a compromise but it is an advantage of the present invention that an amount of dextrine, particularly of yellow corn dextrine, which gives very
10 effective gangue depression is well below the amount that seriously depresses metal values, particularly in pyritic ores. In general, effective depression of noncarbonaceous gangue begins with amounts of dextrine from about 0.2
15 lb./ton to 0.3 lb./ton, depending on the dextrine. In the case of some ores, amounts of dextrine as high as 6 lbs./ton have been used with success. In general, however, it is desirable to
20 keep the dextrine as low as possible and with most ores amounts of dextrine from 1 to 2 lbs./ton give good results but, of course, the invention is not limited to this particular range. In some cases, the ore to be floated is of low
25 grade and a compromise may be desirable in the amount of dextrine used since the larger amounts of reagent required would cost more and not be worth it.

The present invention may be used in rougher
30 flotation of the ore where desired or it may be used only in a cleaning operation. The advantage of the invention is particularly high in cleaning and therefore the best operating procedure may involve a rougher float without dextrine or with smaller amounts of dextrine.
35

It is an advantage of the present invention that it is not limited to any particular flotation procedure. For example, the addition of the depressing agents of the present invention need
40 not take place prior to flotation. The point at which they are introduced, whether in the grinding circuit, classifier, etc., will depend on the particular ore being floated.

The exact mechanism by which the dextrines
45 of the present invention operate has not been definitely determined and the present invention is not limited to any theory of action. It is probable that two factors may be involved, one an alteration of the surface of the gangue so
50 that it does not attach itself to the bubbles during froth flotation. This might be called a true depressing action. The second factor may lie in the dispersing of fine gangue particles and therefore preventing them from adhering to min-
55

eral values which are to be floated. It is also possible that these factors may be effective in varying degrees in the cases of different ores and no limitation to any particular theory of action is intended in the present invention, the above discussion being made for the purpose of advancing what appears to be the most probable reason in the light of present knowledge. It is possible that other factors may also be effective.

I have described and claimed the use of dex-
trines in the depression of carbonaceous gangue
in my Patent No. 2,145,206 dated January 24,
1939, and the present case is not intended to in-
clude the depression of carbonaceous material.

The invention will be described in detail in the
following specific examples in conjunction with
various dextrans and with different typical non-
carbonaceous ores. The invention is, of course,

conditioned with the following reagents: sec-
ondary butyl xanthate, 0.15 lb./ton; a fifty-fifty
mixture of sodium diethyl- and disecundary
butyl-dithiophosphates, 0.05 lb./ton; and pine
oil, 0.062 lb./ton. Flotation was effected in
Fagergren flotation machines and in Test #4
the pulp was conditioned with 2.0 lbs./ton yellow
corn dextrine; in Test #5 with 3.0 lbs./ton yellow
corn dextrine; in Test #6 with 3.0 lbs./ton
white corn dextrine; in Test #7 with 3.0 lbs./ton
white potato dextrine. The results of these
tests were compared with those of Test #3, simi-
larly conducted except that no dextrine was em-
ployed and with those of Tests #8 and #9 in
which were used 2.0 lbs./ton soda ash (Test #8)
and 2.0 lbs. sodium silicate per ton (Test #9),
two reagents frequently used to overcome slime
interference during flotation.

Test No.	Feed		Concentrate				Tailing		
	Gs.	Oz./ton Au	Wt., percent	Ratio conc.	Oz./ton Au	Rec. per- cent Au	Wt., percent	Oz./ton Au	Rec. per- cent Au
3.....	598.0	0.326	5.92	16.89:1	4.620	84.05	94.08	0.055	15.95
4.....	599.0	0.320	3.26	30.67:1	7.940	80.94	96.74	0.063	19.06
5.....	603.4	0.319	2.22	45.05:1	11.480	79.94	97.78	0.065	20.06
6.....	606.3	0.324	2.03	49.26:1	12.660	79.32	97.97	0.068	20.68
7.....	602.6	0.317	1.59	62.89:1	16.375	82.02	98.41	0.058	17.98
8.....	600.0	0.308	5.17	19.34:1	4.900	82.14	94.83	0.058	17.86
9.....	603.5	0.319	4.23	23.64:1	6.200	82.13	95.77	0.060	17.87

not limited to the details of the specific examples
which are typical illustrations only.

Example 3

Example 1

A gold ore from South Africa containing py-
rite, chalcopryrite, bornite, pyrrhotite, quartz and
sericite and assaying 0.396 to 0.410 oz./ton Au
and about 92.5% insoluble, was subjected to flota-
tion with and without yellow corn dextrine. The
ore was conditioned with the following reagents:
secondary butyl xanthate, 0.35 lb./ton; a fifty-
fifty mixture of sodium diethyl- and disecundary
butyl-dithiophosphates, 0.03 lb./ton; and pine oil,
0.062 lb./ton. Flotation was effected in Fager-

Comparative flotation tests with and without
yellow corn dextrine were conducted on a cop-
per ore containing a large amount of talcose ma-
terial and assaying 1.05-1.12% copper and about
64-65% insoluble. The following reagents were
used: secondary butyl xanthate, 0.075 lb./ton,
and pine oil, 0.031 lb./ton. Flotation was effected
in Fagergren flotation machines. In Test #10
no depressant was used; in Test #11 yellow corn
dextrine, 0.5 lb./ton, was agitated with the pulp
prior to the addition of the above-listed re-
agents.

Test No.	Feed		Concentrate						Tailings		
	Gs.	Cu, percent	Wt., percent	Ratio conc.	Cu, percent	Rec. per- cent Cu	Rec. insol.	Total, percent	Wt., percent	Cu, percent	Rec. Cu, percent
10.....	601.4	1.12	14.53	6.88:1	5.45	70.54	12.20	-----	85.47	0.39	29.46
11.....	600.5	1.05	10.94	9.14:1	7.00	73.33	8.32	-----	89.06	0.31	26.67

gren flotation machines and prior to the treat-
ment with the above-listed reagents, the pulp
was conditioned in Test #2 with 0.5 lb./ton yellow
corn dextrine. The results of Test #2 were
compared with those of Test #1, similarly con-
ducted except that no dextrine was employed.
The results of these tests are as follows:

Example 4

Comparative flotation tests with and without
yellow corn dextrine were conducted on a mag-
netite ore from Pennsylvania containing about
0.8% copper as sulfides. The gangue was com-
posed mainly of talc, sericite, mica, and quartz

Test No.	Feed		Concentrate					Tailing		
	Gs.	Oz./ton Au	Wt., percent	Ratio conc.	Oz./ton Au	Rec. per- cent Au	Rec. per- cent ins.	Wt., percent	Oz./ton Au	Rec. per- cent Au
1.....	602.4	0.396	7.70	12.99:1	4.810	93.43	4.94	92.30	0.028	6.57
2.....	601.7	0.410	5.27	18.98:1	7.090	91.22	2.94	94.73	0.038	8.78

Example 2

A gold ore from the Philippine Islands, con-
taining gold, pyrite, chalcopryrite, azurite, quartz,
magnetite, and limonite and assaying 0.308 to
0.326 oz./ton Au, was subjected to flotation with
and without dextrine. This ore exhibited a slime
interference during flotation. The ore pulp was

and the characteristics of the ore were such that
during the concentration of the copper by flota-
tion a rather voluminous froth was produced.
This froth has a tendency to carry a substantial
amount of gangue and fine magnetite and thus
the grade of the concentrate in copper is low-
ered. In addition to improving the metallurgy,

the use of yellow corn dextrine aided materially in overcoming this excessive frothing. The following reagents were used: sodium isopropyl xanthate, 0.20 lb./ton, and a synthetic alcohol-hydrocarbon frother, 0.06 lb./ton. Flotation was effected in Fagergren flotation machines and in Test #12 yellow corn dextrine, 0.5 lb./ton, was agitated with the pulp prior to adding the above listed reagents. In Test #13, no dextrine was used.

ence of a dextrine in amounts sufficient to eliminate a major portion of the slimy gangue from the concentrate, the flotation taking place in the presence of a promoter for the values of the ore.

3. A method of floating noncarbonaceous base metal ores containing barren, non-metalliferous, slimy gangue which comprises subjecting an aqueous pulp of the noncarbonaceous base metal ore to froth flotation in the presence of a dextrine in amounts sufficient to eliminate a major portion

Test No.	Feed		Concentrate				Tailings		
	Gs.	Cu, percent	Wt., percent	Ratio conc.	Cu, percent	Rec.; percent Cu	Wt., percent	Cu, percent	Rec. percent Cu
12	950.5	0.829	8.89	11.25:1	8.262	88.54	91.11	0.104	11.46
13	887.2	0.853	7.07	14.14:1	10.950	90.74	92.93	0.085	9.26

The above examples demonstrate that dextrines of the present invention may be used effectively for the depression of noncarbonaceous gangue during flotation. In the case of the above-described gold ores, an increase in the ratio of concentration, an increase in the gold content of the concentrate, and a decrease in the recovery of insoluble in the concentrate resulted at the expense of only a relatively small loss in gold recovery. Thus, for example, referring to the results of Example 1, the addition of yellow corn dextrine to the ore pulp increased the ratio of concentration about 30% and the gold content of the concentrate about 70%, while the gold recovery decrease was less than 2%.

In the case of the copper ores, no compromise is necessary. The addition of yellow corn dextrine, for example, to the ore pulp of Example 4 increases the ratio of concentration about 20%, the copper content of the concentrate about 25%, and the copper recovery about 2%.

The above examples illustrate the application of my invention to typical metallic ores, but it is equally useful with non-metallic ores such as, for example, the flotation of cement rock and the like.

It is an advantage of the present invention that since the grade of concentrate and ratio of concentration in all cases is increased by the addition of a dextrine as a gangue depressant, shipping and treatment charges on such concentrates are less in cases where the concentrates must be shipped for further treatment and this fact makes the process a more economical one than those of the prior art.

What I claim is:

1. A method of floating noncarbonaceous metallic ores containing barren, non-metalliferous, slimy gangue which comprises subjecting an aqueous pulp of the noncarbonaceous ore to froth flotation in the presence of dextrine in amounts sufficient to eliminate a major portion of the slimy gangue from the concentrate, the flotation taking place in the presence of a promoter for the values of the ore.

2. A method of floating noncarbonaceous precious metal ores containing barren, non-metalliferous, slimy gangue which comprises subjecting an aqueous pulp of the noncarbonaceous precious metal ore to froth flotation in the pres-

ence of the slimy gangue from the concentrate, the flotation taking place in the presence of a promoter for the values of the ore.

4. A method of floating noncarbonaceous metallic ores containing barren, non-metalliferous, slimy gangue which comprises subjecting an aqueous pulp of the noncarbonaceous ore to froth flotation in the presence of yellow corn dextrine in amounts sufficient to eliminate a major portion of the slimy gangue from the concentrate, the flotation taking place in the presence of a promoter for the values of the ore.

5. A method of floating noncarbonaceous precious metal ores containing barren, non-metalliferous, slimy gangue which comprises subjecting an aqueous pulp of the noncarbonaceous precious metal ore to froth flotation in the presence of yellow corn dextrine in amounts sufficient to eliminate a major portion of the slimy gangue from the concentrate, the flotation taking place in the presence of a promoter for the values of the ore.

6. A method of floating noncarbonaceous base metal ores containing barren, non-metalliferous, slimy gangue which comprises subjecting an aqueous pulp of the noncarbonaceous base metal ore to froth flotation in the presence of yellow corn dextrine in amounts sufficient to eliminate a major portion of the slimy gangue from the concentrate, the flotation taking place in the presence of a promoter for the values of the ore.

7. A method of floating a noncarbonaceous gold ore containing barren, non-metalliferous, slimy gangue which comprises subjecting an aqueous pulp of the gold ore to froth flotation in the presence of yellow corn dextrine in amounts sufficient to eliminate a major portion of the slimy gangue from the concentrate, the flotation taking place in the presence of a promoter for the values of the ore.

8. A method of floating a noncarbonaceous copper ore containing barren, non-metalliferous, slimy gangue which comprises subjecting an aqueous pulp of the copper ore to froth flotation in the presence of yellow corn dextrine in amounts sufficient to eliminate a major portion of the slimy gangue from the concentrate, the flotation taking place in the presence of a promoter for the values of the ore.

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