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FLOTATION PROCESS.

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This invention relates to the separation of minerals from each other and to the concentration of the more valuable constituents of an ore. More particularly, the invention relates to the separation of minerals by flotation processes. It is especially applicable to froth flotation processes involving ores whose valuable constituents are difficult to concentrate by flotation. The invention aims to provide certain improvements in flotation processes, and this aim is realized by the provision of a new class of mineral-collecting agents for froth flotation processes.

Many organic substances have been used as mineral-collecting agents in flotation, more particularly in froth flotation. With certain ores practically all known flotation reagents are unsatisfactory, since by their use only moderately high recoveries of the valuable mineral constituents can be obtained. Many attempts have been made to improve these recoveries, as for example by "reconstruction" of certain oils, by heating with sulfur or sulfur compounds, but the recoveries of metal values obtained are still unsatisfactory.

A mineral-collecting agent in order to be effective in flotation processes must have such properties that it will readily coat or otherwise appropriately modify the surfaces of the valuable mineral particles and thereby render them less easily wetted by water or the aqueous solution in which the ore particles are suspended during the flotation operation. The mineral-collecting reagent must also selectively coat or otherwise modify the valuable mineral particles in preference to the gangue particles and must firmly adhere to the mineral particles or maintain its modifying influence during the flotation operation.

The present invention is based on the discovery that the water repellent reaction products of the reaction between metallic xanthates and organic acid chlorides are effective flotation reagents. Thus, when potassium ethyl xanthate is allowed to react with ethyl chlorocarbonate, or acetyl-chloride, or carbonyl-chloride, or sulfuryl-chloride, the resulting crude reaction product, after washing with water to remove soluble substances and any undecomposed xanthate, is a substantially water-insoluble liquid or residue which when used in the customary flotation operations as a mineral-collecting agent causes the sulfide minerals to float readily with an attendant high recovery of these mineral values. I believe that the effectiveness of these reaction products in flotation is due to the fact that they contain substances whose molecules attach themselves firmly to the valuable mineral particles by residual valence forces, and, at the same time, present a water-repellent surface to the aqueous medium in the flotation pulp. By "water-repellent surface" I mean one that is less readily wetted by water than the mineral particles to be floated and one that will therefore present a surface to the flotation pulp which will more readily allow attachment to an air liquid interface such as the surface of an air bubble in a flotation pulp.

The following examples will illustrate methods of preparation of reaction products available in the practice of the invention:

1. Thirty grams of potassium ethyl xanthate were made into a paste with ethyl alcohol. To this mixture in a flask with a reflux condenser 20 grams of ethyl chlorocarbonate (C_2H_5OCOCl) were added while keeping the mixture cool with water. After allowing the reaction mass to stand for about one hour, then filtering and diluting with a large volume of cold water, a yellow oil separated out as the crude reaction product.

2. Sixteen grams of potassium ethyl xanthate were made into a paste with carbon tetra chloride and eight grams of acetyl chloride (CH_3COCl) added slowly over a period of fifteen minutes during which considerable heat is liberated. After standing one-half hour, the reaction mass was washed with a large quantity of water, and the crude oleaginous reaction product collected from a separatory funnel.

3. Two hundred cubic centimeters of a saturated solution of carbonyl chloride ($COCl_2$) in toluene were added to one hundred and sixty grams of potassium ethyl xanthate. A reaction took place with the liberation of considerable heat. The resulting mixture was washed with a large quantity of water and the reaction product in the form of a substantially water-insoluble residue was collected from a separatory funnel.

4. Twenty-four grams of potassium ethyl xanthate were stirred with one hundred

cubic centimeters of absolute alcohol, and while keeping the temperature at 0 to 5° C., twenty-seven grams of sulphuryl chloride (SO_2Cl_2) were added over a period of two hours and a quarter. Upon diluting the reaction mass with a large volume of water, a yellow oil separated out and was collected from a separatory funnel as the crude reaction product.

While the foregoing examples illustrate the general method of preparing the reaction products contemplated by the invention, many departures can be made from the methods here described without departing from the spirit of the invention. Thus in the first example, the xanthate may be dissolved in water instead of suspending it in alcohol; and, of course, other organic suspending agents than toluene or carbon tetra-chloride may be used, provided they do not interfere with the reactions or decrease the flotation effectiveness of the resulting reaction product.

The following flotation results on a difficultly flotatable ore have been obtained with the crude reaction products prepared in accordance with the examples hereinbefore given:

Reaction product of preceding examples	1	2	3	4
lbs. of crude reaction product per ton of ore	0.20	0.20	0.20	0.20
Cresylic acid per ton of ore	0.50	0.50	0.50	0.50
Sulfuric acid per ton of ore	14.00	14.00	14.00	14.00
% Cu. heads	2.35	2.27	2.35	2.27
% Cu. tails	0.20	0.53	0.23	0.39
% Recovery	93.7	81.4	94.00	88.0

From the foregoing description, it will be understood that the mineral-collecting agents contemplated by the invention are water-repellent reaction products resulting from the reaction between a metal xanthate and an organic acid chloride. Any metal xanthate, such as an alkali metal, alkali earth metal or heavy metal xanthate, may be used in carrying out the invention. While I have hereinbefore particularly mentioned ethyl xanthate, it is to be understood that other alkyl xanthates, such as amyl, butyl, propyl, etc., as well as aryl xanthates, are available in preparing the reaction products contemplated by the invention.

The reaction products may be introduced into the ore or mineral pulp in any convenient manner and at any appropriate stage preceding the flotation operation. In order to effectively disperse or disseminate the reaction product throughout the entire body of the pulp, the reaction product may be dissolved in an appropriate solvent and the resulting solution added to the pulp. Insoluble oils, such as the commonly used flotation oils, kerosene oil, etc., have been satisfactorily used as such solvents.

The quantity of the reaction product to be employed in practicing the invention depends to some extent upon the particular ore being treated. In general, one-half pound, and less, per ton of dry ore gives satisfactory results. Since the reaction products are for the most part mineral-collecting agents only and substantially devoid of frothing power, it is generally necessary, in the practice of the invention, to use these reaction products in conjunction with an appropriate frothing agent, such as cresylic acid, pine oil, or the like.

The reaction products contemplated by the invention are effective in acid, neutral and alkaline circuits. This is of more particular significance in the case of acid circuits, because the present day mineral-collecting agents are for the most part less effective, and in many cases entirely unsuited for use, in acid circuits.

It will be understood by those skilled in the art that the present invention is applicable to the treatment by flotation of various kinds of mineral mixtures both natural and artificial. In the appended claims I have accordingly employed the terms "mineral" and "ore" in a broad sense to include ores, mineral products and all materials amenable to concentration or similar treatment by the flotation processes.

I claim:

1. The improvement in the concentration of minerals by froth flotation which comprises subjecting the mineral in the form of a pulp to a flotation operation in the presence of a water-repellent reaction product resulting from the reaction between a metal xanthate and an organic acid chloride.

2. The improvement in the concentration of minerals by froth flotation which comprises subjecting the mineral in the form of an acid pulp to a flotation operation in the presence of a water-repellent reaction product resulting from the reaction between a metal xanthate and an organic acid chloride.

3. The improvement in the concentration of minerals by froth flotation which comprises subjecting the mineral in the form of a pulp to a flotation operation in the presence of the substantially water-insoluble portion of the products of the interaction of a metal xanthate and an organic acid chloride.

4. The improvement in the concentration of minerals by froth flotation which comprises subjecting the mineral in the form of an acid pulp to a flotation operation in the presence of the substantially water-insoluble portion of the products of the interaction of a metal xanthate and an organic acid chloride.

5. The improvement in the concentration of minerals by froth flotation which com-

prises subjecting the mineral in the form of a pulp to a flotation operation in the presence of a water-repellent reaction product resulting from the interaction of an organic alkyl alkali-metal xanthate and an acid chloride.

6. The improvement in the concentration of minerals by froth flotation which comprises subjecting the mineral in the form of an acid pulp to a flotation operation in the presence of a water-repellent reaction product resulting from the interaction of an organic alkyl alkali-metal xanthate and an acid chloride.

7. The improvement in the concentration of minerals by froth flotation which comprises subjecting the mineral in the form of a pulp to a flotation operation in the presence of a water-repellent reaction product resulting from the interaction of a metal xanthate and an alkyl chlorocarbonate.

8. The improvement in the concentration of minerals by froth flotation which comprises subjecting the mineral in the form of a pulp to a flotation operation in the presence of the substantially water-insoluble portion of the products of the interaction of an alkyl alkali-mental xanthate and an alkyl chlorocarbonate.

In testimony whereof I affix my signature.

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