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UNITED STATES PATENT OFFICE

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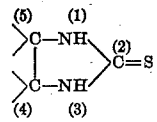
FLOTATION OF MINERALS

No Drawing. Application filed May 20, 1927. Serial No. 193,061.

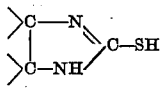
This invention relates to the separation of minerals and the concentration of ores by flotation processes, and is particularly directed to such separation and concentration carried out with the utilization of certain organic sulfur compounds as flotation or mineral collecting agents.

According to the present invention, improved results can be obtained in the separation of minerals and the concentration of ores by carrying out the flotation operation with the addition to the ore of mineral pulp of a pentacyclic thiourea compound, particularly pinacolyl thiourea.

The pentacyclic thiourea compounds employed as the flotation agents or adjuvants in the process of the present invention are the thioimidazolidine bodies which are generally characterized by containing the following atomic grouping:

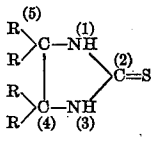


Many compounds which contain this structure exhibit tautomerism and in consequence are sometimes assigned the structure:



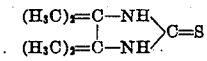
For the purposes of the present invention, these two structures or groupings are regarded as equivalent.

The thioimidazolidines are also known as the thiotetrahydroimidazoles and also as the thiotetrahydroglyoxalines, and those of special interest as flotation agents have the following formula:



where R denotes an akyl group.

Pinacolyl thiourea may be designated as 2-thio-4.4.5.5-tetramethyltetrahydroimidazole and corresponds with the formula:



The flotation agents of the present invention may be prepared by methods described in the chemical literature.

In carrying out the flotation process the flotation agent comprising a pentacyclic thiourea compound may be incorporated with the ore or mineral pulp in any suitable manner or at any suitable time which will insure a satisfactory flotation operation. For example, it may be introduced in the free state into the mill in which the ore is being ground, or it may be dissolved, suspended, or dispersed in any suitable solvent or dispersing agent as, for example, in one or more of the usual flotation oils or oil mixtures, or in any suitable organic solvent or medium, or in water or in alkali or an alkaline reagent, and the resulting solution, suspension, or dispersion incorporated with the ore or mineral pulp. While the agents of the present invention show marked action as flotation or collecting agents in ore concentration, they ordinarily possess insufficient frothing qualities and are therefore generally used to advantage in conjunction with any suitable or well-known frothing agent, e. g., pine oil, crude turpentine, coal tar acids, etc. They may be also sometimes used to advantage in conjunction with other flotation agents. They may be used in the pure or purified state; and, in general, they may also be employed in the crude or impure state.

The process of the present invention can be carried out in any suitable apparatus, for example, those of the pneumatic type such as the Callow cell, or those where the air is incorporated with the mixture by agitation such as the Janney apparatus, or the like.

It is of advantage in some cases, as with certain ores, to subject the ore pulp to the action of an amount of alkali sufficient to give it an alkaline reaction before subjecting it to flotaton with the flotation agents of the present invention. The alkali may be caustic alkali such as caustic soda, or an alkaline salt

such as soda ash, or it may be calcium oxide or hydrate.

In the differential separation of various minerals, such as zinc blende from associated minerals, the presence of an alkali metal cyanide, or of copper sulfate or other salts, is sometimes advantageous.

The amount of flotation agent required to be used in the flotation process will vary, it depending partly on the character and composition of the ore, partly on the particular pentacyclic thiourea compound employed, and partly on other factors. Ordinarily, one-sixth to one-half pound of the flotation agent per ton of dry ore will be sufficient, but larger or smaller amounts than this may be used.

The invention will be further illustrated by the following specific example, but it will be understood that the invention is not limited thereto. The parts are by weight.

Example.—500 parts of a copper sulfide ore (of the Miami Copper Co.) assaying 1.21 percent copper was ground in a ball mill with 300 parts of water, 0.75 parts of hydrated lime (equivalent to 3 pounds per ton of ore), and 0.0625 parts of pinacolyl thiourea (equivalent to one-fourth pound per ton of ore), until practically all of it was sufficiently fine to pass through a 40-mesh screen. The ground pulp was diluted with sufficient water to give a pulp containing about 16 percent solids and subjected to flotation in a Janney mechanical apparatus. The mixture was agitated for 30 minutes during which time about 0.08 parts of pine oil was introduced. 30.2 parts of a concentrate assaying 15.3 percent copper was obtained which is a recovery in the concentrate of 76.7 percent of the copper. The tailings assayed 0.29 percent copper. It will be noted that the equivalent of about 16.5 tons of ore was required to give one ton of concentrate.

It will thus be noted that the present invention contemplates the utilization as flotation agents in the separation of minerals and the concentration of ores of pentacyclic thiourea compounds; that the said flotation agents may be incorporated in or with the ore or mineral pulp at any suitable time and in any suitable manner; that they may be used in the free state or in admixture with one another or in solution, suspension or dispersion in any suitable solvent or medium; and that they may be used in conjunction with other flotation agents or with frothing agents, or with both.

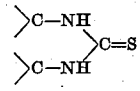
The present invention is of more or less general application to the treatment of different kinds of mineral substances, both natural and artificial, by flotation.

It will be further understood that the invention is not limited to the use of the particular agents or ingredients mentioned in the example and that other agents, particularly other flotation agents of the class specified, can be similarly used.

We claim:

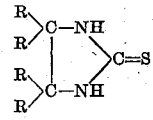
1. In effecting the separation of minerals, the process which comprises incorporating with the mineral pulp a pentacyclic thiourea compound, and subjecting the resulting mixture to a froth flotation operation.

2. In effecting the separation of minerals, the process which comprises incorporating with the mineral pulp a thioimidazolidine compound which embodies within its composition the following probable grouping:



and subjecting the resulting mixture to a froth flotation operation.

3. In effecting the separation of minerals, the process which comprises incorporating with the mineral pulp a thioimidazolidine compound corresponding with the following probable formula:

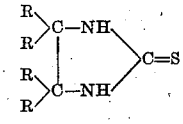


where R denotes an alkyl group, and subjecting the resulting mixture to a froth flotation operation.

4. In effecting the separation of minerals, the process which comprises incorporating pinacolyl thiourea with the mineral pulp, and subjecting the resulting mixture to a froth flotation operation.

5. In effecting the concentration of a copper sulfide ore, the process which comprises subjecting a pulp of the ore to a froth flotation operation in the presence of a pentacyclic thiourea.

6. In effecting the concentration of a copper sulfide ore, the process which comprises subjecting a pulp of the ore to a froth flotation operation in the presence of a thioimidazolidine having the following probable formula:



wherein R denotes an alkyl group.

7. In effecting the concentration of a copper sulfide ore, the process which comprises subjecting a pulp of the ore to a froth flotation operation in the presence of pinacolyl thiourea.

In testimony whereof we affix our signatures.

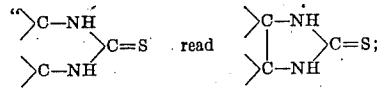
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Certificate of Correction

Patent No. 1,801,319. Granted April 21, 1931, to

FREDERICK G. MOSES ET AL.

It is hereby certified that error appears in the printed specification of the above-numbered patent requiring correction as follows: Page 1, line 12, for the word "of" read *or;* page 2, after line 78, claim 2, for the formula



and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 19th day of May, A. D. 1931.

[SEAL.]

M. J. MOORE,
Acting Commissioner of Patents.