Patented May 5, 1942 2,281,880

UNITED STATES PATENT OFFICE

2,281,880

FLOTATION

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No Drawing. Application October 9, 1939, Serial No. 298,593

12 Claims. (Cl. 209—166)

This invention is concerned with mineral separation with the aid of metallo-organic compounds in which a metal is directly united to a nuclear carbon atom of an organic radical, such for example as an alkyl, aryl or aralkyl group. The invention aims to provide improvements in processes of ore concentration, particularly in the process of froth flotation, and affords new reagents for such purposes.

It has been appreciated heretofore that the addition of small amounts of a variety of organic compounds to a mineral pulp facilitates the process of selection by flotation, but so far as I am aware, I am the first to discover that mineral separation by flotation is facilitated by including in the pulp to be subjected to flotation a relatively small proportion of a metallo-organic compound, such for example as lead tetraethyl, in which the lead atom is united directly through nuclear carbon atoms to four alkyls. The metallo-organic compound employed should be relatively stable and conveniently may be selected from the oil-soluble compounds of this character, so that it can be introduced in solution into the pulp and so dispersed therein with greater ease.

The organo-metallic compounds with which the invention is concerned are numerous. Most of the important metals form definite compounds of this class with organic radicals, such as alkyl, aryl or aralkyl groups. Examples of such compounds suitable for the practice of the invention include metallo-organic compounds of lead, such as tetraethyl lead, tetraphenyl lead, triethyl lead bromide, sodium tetraethyl lead, triethyl lead chloride, triphenyl lead iodide ond triphenyl ethyl lead; metallo-organic compounds of mercury, such as diethyl mercury, dimethyl aniline mercury and phenyl mercuric bromide; and metallo-organic compounds of tin, such as tetraethyl tin, trimethyl tin sulfide, triethyl tin sulfide and tetrabenzyl tin. The composition of these organo-metallic, or metallo-organic, compounds often corresponds with that of the metallic chlorides or other halides from which the compounds may be derived by complete or partial replacement of halogen by the organic radical, say alkyl. In general, the alkyl metallo-organic compounds are colorless mobile liquids that boil without decomposition at relatively low temperatures. Some of the compounds tend to decompose rapidly in the presence of air, but others, exemplified by the compounds of mercury, lead and tin are highly stable.

Of the various metallo-organic compounds that may be employed, I prefer those of mercury, lead and tin in which the metal is combined with one or more alkyl groups. One of the most satisfactory, both from the standpoint of availability and that of performance is lead tetraethyl, and hereinafter I describe my invention in detail with reference to this compound.

Lead tetraethyl is soluble in hydrocarbons, for example, in gasoline or light mineral oil, and to facilitate measurement and dispersion I prefer to employ it in a hydrocarbon solution. So dissolved, the lead tetraethyl may be added to a pulp to be subjected to flotation, either alone or in conjunction with other collecting reagents, and the resulting mixture thereafter subjected to froth flotation in known manner.

I have found that in many instances the beneficial action of the metallo-organic compound is enhanced if it is employed with a sulfidizing agent containing a polar sulphur group, such for example as hydrogen sulfide, sodium sulfide, calcium polysulfide, or ammonium sulfide.

The following tests illustrate a preferred practice of the invention. They were made upon ore from the mines of the Braden Copper Company at Sewell, Chile. This ore contained a relatively small proportion of molybdenite and sulfide and oxidized copper minerals. This ore or "feed" was in the form of an aqueous slime pulp. In each instance the charge of pulp contained 400 grams of ore mixed with 1250 grams of water.

Test No. 1

A charge of pulp was first subjected to a preliminary or "roughing" froth flotation operation to produce a first concentrate and an intermediate tailing. In this preliminary operation, the charge was agitated for two minutes in the presence of .015 gram of "Ethyl-Minerec," i. e., ethoxy thio carbonyl ethoxy carbonyl sulfide; .02 gram of "Sodium Aerofloat," i. e., sodium diisopropyl dithio phosphate; .08 gram of cresylic acid; and 1 gram of sulphuric acid. This agitation served to thoroughly incorporate the reagents in the pulp. Thereafter the pulp was subjected to froth flotation in a laboratory type flotation machine, the concentrate being removed as froth at half minute intervals over a period of ten minutes. The unfloated solids constituted the intermediate tailing.

The intermediate tailing was mixed with .16 gram of light hydrocarbon oil containing five percent by weight of lead tetraethyl. The mixture was then sulfidized with hydrogen sulfide gas, the excess gas being removed by suction, and there-

after the mixture was agitated for two minutes with .015 gram of "Ethyl-Minerec," .02 gram of "Sodium Aerofloat" and .08 gram of cresylic acid. After agitation the mixture was subjected to a flotation operation, froth being removed at intervals over a period of twelve minutes. The mineral extracted in this froth constituted a second concentrate, and the unfloated material was final tailing.

In a second operation run for purposes of comparison and designated hereinafter as a "Blank Test A," a like charge of the same ore was subjected to exactly similar operations with the same reagents except that in treating the intermediate tailing, the hydrocarbon oil and lead tetraethyl were not employed.

The following are the results obtained in Test No. 1 and in the Blank test:

	Test No. 1	"Blank test A"
Feed:		
Percent copper	3.07	3.02
Percent molybdenite	.119	.107
First concentrate:		
Percent copper	38.00	35.50
Percent molybdenite	.320	.255
Second concentrate:		
Percent copper	21.75	15.65
Percent molybdenite	1.41	.40
Final tailing:		
Percent copper	.32	.72
Percent molybdenite	.040	.090

Percentage distribution of mineral contained in feed

	Test No. 1	"Blank test A"
First concentrate:		
Copper	55.06	63.01
Molybdenite	11.79	12.61
Second concentrate:		
Copper	35.22	14.55
Molybdenite	57.84	10.09
Final tailing:		
Copper	9.72	22.44
Molybdenite	30.37	77.30

TEST NO. 2

A charge of the ore pulp identical to that employed in Test No. 1 was subjected to flotation under the conditions of Test No. 1 and with the same reagents, with the exception that the sulfidizing step was omitted. In other words, a standard charge of the pulp was first agitated for two minutes with .015 gram of "Ethyl-Minerec," .02 gram of "Sodium Aerofloat," .08 gram cresylic acid and 1 gram of sulfuric acid, this mixture being then subjected to flotation with froth removal at half minute intervals for ten minutes. The intermediate tailing or unfloated material from this preliminary concentration operation was then mixed with .16 gram of light hydrocarbon oil containing five percent by weight of lead tetraethyl; then .015 gram of "Ethyl-Minerec," .02 gram of "Sodium Aerofloat" and .08 gram of cresylic acid was added and mixed over a two minute interval. The intermediate tailing thus prepared or "conditioned" was subjected to froth flotation for twelve minutes to yield a final tailing and a second concentrate.

A "Blank test B" was run in which all of the conditions of Test No. 2 were maintained with the exception that the hydrocarbon oil containing lead tetraethyl was omitted.

To summarize the results of Test No. 2 and Blank test B, the recovery of copper in Test No. 2 was 5.1 percent greater than in Test B, while the recovery of molybdenite in Test No. 2 was 6.9 percent greater than in Test B.

The hydrocrabon oil which is mixed with the lead tetraethyl serves as a mere solvent or diluent. Tests run with straight hydrocarbon oil containing no lead tetraethyl were made and failed to produce the improvement in mineral recovery which was experienced when the lead tetraethyl was present.

It should be understood that the practice of the invention is not limited to the use of metallo-organic compounds in conjunction with the other reagents employed in the foregoing examples. On the contrary, such compounds may be employed with beneficial results in conjunction with almost any reagents customarily employed in the flotation of a given ore and they offer advantages in the treatment of both sulfide and oxidized ores.

I claim:

1. The process of concentrating a metalliferous ore which includes agitating a pulp of the ore with a metallo-organic compound in which a metal is united directly with a nuclear carbon atom of an organic radical selected from the group consisting of alkyl, aryl, and aralkyl radicals, and subjecting the pulp to the action of a sulfidizing agent to yield a floating concentrate, said concentrate being separated.

2. In the treatment of an aqueous mineral pulp to effect concentration of metalliferous minerals therein, the improvement which comprises treating the pulp with a sulfidizing agent and thereafter subjecting the pulp to froth flotation in the presence of a metallo-organic compound in which a metal is united directly with a nuclear carbon atom of an organic radical selected from the group consisting of alkyl, aryl and aralkyl.

3. In the treatment of an aqueous mineral pulp to effect concentration of the metalliferous minerals therein, the improvement which comprises incorporating into the pulp a sulfidizing agent and a metallo-organic compound in which a metal is combined with at least one alkyl group by direct union with a nuclear carbon atom thereof, and subjecting the pulp thus treated to froth flotation.

4. In the treatment of an aqueous mineral pulp to effect concentration of metalliferous minerals therein, the improvement which comprises subjecting the pulp to treatment with a sulfidizing agent selected from the group consisting of hydrogen sulfide, sulfides of the alkali metals, calcium polysulfide and ammonium sulfide, also incorporating into the pulp a metallo-organic compound in which a metal is united directly to a nuclear carbon atom of an organic radical, and subjecting the resulting mixture to froth flotation.

5. In the treatment of a mineral pulp to effect concentration of metalliferous minerals therein, the improvement which comprises subjecting the pulp to froth flotation in the presence of lead tetraethyl and a sulfidizing agent.

6. The process of concentrating a metalliferous ore which includes agitating a pulp of the ore with a plurality of flotation agents including a metallo-organic compound in which a metal is united directly with a nuclear carbon atom of an organic radical selected from the group consisting of alkyl, aryl, and aralkyl and simultaneously with another and different type of collecting reagent containing a polar sulphur group to

yield a floating concentrate, and separating the concentrate.

7. In the treatment of a pulp to effect concentration of metalliferous minerals therein, the improvement which comprises subjecting the pulp to froth flotation in the presence of a metallo-organic compound in which a metal is combined with at least one alkyl group through direct union with a nuclear carbon atom thereof and simultaneously in the presence of another and different type of collecting reagent containing a polar sulphur group.

8. In the treatment of a mineral pulp to effect concentration of metalliferous minerals therein, the improvement which comprises subjecting the pulp to froth flotation in the presence of a metallo-organic compound consisting of a metal combined with one or more alkyl groups through direct union with a nuclear carbon atom thereof and simultaneously in the presence of another and different type of collecting reagent containing a polar sulphur group.

9. In a treatment of a mineral pulp to effect concentration of metalliferous minerals therein, the improvement which comprises subjecting the pulp to froth flotation in the presence of a hydrocarbon solution of a metallo-organic compound in which a metal is combined with at least one organic radical selected from the group alkyl, aryl and aralkyl by direct union with a nuclear carbon atom of the radical and simultaneously in the presence of another and different type of collecting reagent containing a polar sulphur group.

10. In froth flotation of an aqueous mineral pulp to effect concentration of metalliferous minerals therein, the improvement which comprises subjecting the pulp to froth flotation in the presence of lead tetraethyl together with another least one other collecting reagent containing a polar sulphur group.

11. In froth flotation of an aqueous mineral pulp to effect concentration of metalliferous minerals therein, the improvement which comprises subjecting the pulp to froth flotation in the presence of a metallo-organic compound of lead with a plurality of alkyl groups, together with at least one another collecting reagent containing a polar sulphur group of a different type.

12. In froth flotation of an aqueous mineral pulp to effect concentration of metalliferous minerals therein, the improvement which comprises subjecting the pulp to froth flotation in the presence of a metallo-organic compound of a metal selected from the group consisting of mercury, lead and tin, said metal being united directly to a nuclear carbon atom of at least one alkyl group, together with another and different type of collecting reagent containing a polar sulphur group.

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CERTIFICATE OF CORRECTION.

Patent No. 2,281,880. May 5, 1942.

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It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 3, second column, line 9, claim 10, for "least one other" read --and different type of--; and line 17, claim 11, for "another" read --other--; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 14th day of July, A. D. 1942.

Henry Van Arsdale,
Acting Commissioner of Patents.

(Seal)