Patented Apr. 3, 1934

1,953,431

UNITED STATES PATENT OFFICE

1,953,431

FLOTATION PROCESS FOR NONSULPHIDE ORE

John M. Patek, Milwaukee, Wis.

No Drawing. Application September 24, 1931, Serial No. 564,974

4 Claims. (Cl. 209—167)

This invention relates to the concentration of non-sulphide ore minerals by flotation methods, especially in connection with the usual method of using a saponifiable substance as the principal flotation agent, and is particularly adapted to the concentration of ores composed of oxides, silicates and other non-sulphide minerals, such as the oxide ores of tin and tungsten.

It is well known that the usual method of employing a fatty acid to cause the concentration by flotation of oxide, silicate and other non-sulphide ore minerals is of little practical use since the gangue minerals are floated almost as readily as the ore minerals and little or no separation is accomplished.

Special methods of flotation which improve the recovery of non-sulphide ore from the gangue minerals have been proposed. At best, by these older methods, the concentrated ore contains large quantities of gangue minerals which are not separable. For example, a natural material which contains the mineral oxide of a valuable element in small concentrations may at the same time contain large concentrations of quartz, mica, tourmaline, epidote. The treatment of such a material by methods known prior to my invention results only in the separation of the quartz and mica leaving the concentrated material still contaminated with the epidote and tourmaline originally present. It is only under rare and peculiar circumstances that such a separation is of practical value, to-wit: when the original material is luckily free of such constituents as tourmaline, epidote, etc.

I have, on the other hand, discovered that many of the gangue minerals which formerly were not separable may now be separated by rendering them unsusceptible to the collecting action of even the most active flotation agents. This I accomplish by contacting the mineral with a jellylike mixture formed by adding small amounts of a soluble silicate to a solution containing small amounts of certain compounds formed with the specific metallic elements hereinafter to be specified. The gangue mineral particle thus contacted will adsorb a coating of material, in the form of a metal silicate gel, formed by the interaction of the soluble silicate with the metal compound. This coating of metal silicate gel provides a positive resistance to the collecting action of the flotation agent and the particle so coated will not float. The adsorption of the coating upon the gangue mineral particle depends upon the chemical nature of the surface of the particle itself.

The structure of the gel substance formed is of the general form $MO.SiO_2(H_2O)$, wherein M represents the specific metal employed. Thus the soluble silicate is used only to form an insoluble metal silicate gel which may be selectively adsorbed upon the surfaces of the silicate gangue minerals. A moderate excess of the gel in system is unimportant for this reason. Likewise unimportant is the source of the gel. A soluble silicate may be first reduced to silicic acid by adding strong acid and a soluble metal compound solution, such as lime water added to form the gel, which may then be introduced to the flotation machine.

Many of the non-sulphide ore minerals bear a very weak surface attraction in contrast to the strong surface atraction of the gangue silicates. The ore minerals, consequently, do not adsorb the gel substance, and are, therefore, easily floated by active flotation agents.

The metal compounds added to the flotation circuit do not include all metals, but only metals of a specific class. This class includes metals which have a certain definite characteristic in common, namely, the ability to form a soluble oxide or hydroxide in an alkaline solution. Metals which form such soluble oxides or hydroxides in an alkaline solution will henceforth be referred to as "soluble oxide forming metals". They are of two types:

1.—Amphoteric metals

2.—Alkaline earth metals

Amphoteric metals may be sharply differentiated from all other metals, because amphoteric metals are the only metals that combine with oxygen to form chemical radicles which behave as anions. The type of compound in which the amphoteric metals are introduced into the flotation circuit is the alkaline compound of the metal oxide. An example is sodium aluminate.

The second type of soluble oxide forming metals, the alkaline earth metals, are used as oxides or hydroxides. The principal alkaline earth metals are calcium, magnesium, strontium and barium. When compared to the amphoteric metals, their cost is so low that they find application where a low cost flotation agent is essential.

In my process the material to be treated is ground and mixed with water to form a pulp in the usual manner. To the pulp is then added a small amount of a compound containing a metal, let us say, of the type defined above as the alkaline earth metal type. To the pulp is also added an amount of soluble silicate slightly in excess of the added compound of the metal of the alka-

line earth type. The mixture is then agitated and the gangue mineral particles are caused to adsorb a coating of the gel substance. The ore pulp is then subjected to flotation with a soap or fatty acid and the concentrate recovered in the ordinary manner. The order in which the constituents are added is not particularly important except in certain cases where it is sometimes expedient to first add the metal compound to the silicate to form a gel and then to add this mixture to the pulp. Calcium and antimony compounds are among those advantageously incorporated in this manner.

As a specific example of one manner of carrying on my invention, I may take 2000 grams of wolframite ore, which has been ground and mixed with water to form a pulp. To the pulp I then add 3 grams of sodium aluminate and 5 grams of sodium silicate. The charge is then agitated and in the presence of 1.5 grams of oleic acid and 0.2 grams of pine oil, subjected to flotation in the usual manner. A more specific example is as follows: To 10 drops of sodium silicate in a test tube was added 2 c.c. of water and 1.5 c.c. of dilute sulfuric acid, followed by 2 c.c. of saturated calcium hydroxide solution. A clear, firm gel formed in the tube immediately. The gel was then added to a 50 gram flotation machine containing a partially concentrated cassiterite ore containing 26.5% tin. To the mixture was added water and the ore pulp was then agitated for several minutes followed by the addition of 0.5 lbs. per ton of oleic acid and 0.2 lbs. per ton of terpineol. Flotation was carried out in the usual manner and the cassiterite recovered in the froth. The tailings contained 1.5% tin and the concentrate contained 47% tin, showing a recovery of 98% of the tin.

While I have fully described above the process of my invention and have given particular directions for the practice thereof, I wish it to be understood that I do not intend that the scope of the Letters Patent be limited thereby, but only to be limited by the range of the invention as set forth in the appended claims.

I claim as my invention:

1. The process of concentrating non-sulphide ores which consists in grinding the ore, mixing the same with water to form a pulp, adding the oxide of an alkaline earth metal, a soluble silicate and a saponifiable substance, agitating the mixture while supplying air thereto, and removing the froth produced thereby.

2. The process of concentrating non-sulphide ores which consists in grinding the ore, mixing the same with water to form a pulp, adding an alkaline earth metal silicate gel, a saponifying substance and a frothing agent, agitating the mixture while supplying air thereto, and removing the froth produced thereby.

3. The process of concentrating non-sulphide ores which consists in grinding the ore, mixing the same with water to form a pulp, adding calcium hydroxide, a soluble silicate and a saponifying substance, agitating the mixture while supplying air thereto, and removing the froth produced thereby.

4. The process of concentrating non-sulphide ores which consists in grinding the ore, mixing the same with water to form a pulp, adding an alkaline earth metal oxide and soluble silicate, so as to form a gel, and a saponifiable substance, agitating the mixture while supplying air thereto to form a froth, and removing the froth produced thereby.

JOHN M. PATEK.