Patented June 23, 1942

2,287,274

UNITED STATES PATENT OFFICE

2,287,274

PROCESS OF SEPARATING LEAD AND ZINC SULPHIDES

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No Drawing. Application November 9, 1939, Serial No. 303,712

4 Claims. (Cl. 209—167)

This invention relates to processes of separating zinc sulphide from lead sulphide in ores containing the same, and it more specifically includes processes wherein such ores are subjected to froth flotation in the presence of primary aliphatic amines containing six or more carbon atoms, and water-soluble salts thereof.

Many ores subjected to metallurgical separation for the recovery of metalliferous constituents therein contain lead sulphide, and zinc sulphide. In addition, much siliceous material referred to as gangue is associated with these sulphides. In the past it has been common practise to subject such ores to froth flotation so as to obtain a concentrate rich in lead sulphide (galena) leaving the zinc sulphide (sphalerite) in the tailings along with the gangue. Sphalerite is one of the most difficult sulphide ores to float. The xanthates are almost universally used to bring about this separation. In the book entitled "Flotation" by Gaudin, paragraph 1 on page 210 reads as follows: "Four general methods have been proposed to separate galena from sphalerite and marmolite. These methods are based on the use of (*a*) cyanide with or without zinc sulphate, (*b*) sodium sulphide, (*c*) a soluble sulphite or sulphurous acid with or without zinc sulphate, and (*d*) a chromate or dichromate with or without copper sulphate. Of these methods the first three aim at permitting the galena to float while inhibiting the sphalerite. The last method is aimed at inhibiting the galena while floating the sphalerite. The cyanide-zinc-sulphate method is the most widely used." Potassium xanthate is used in every case in conjunction with the above treatments.

Thus it is apparent from prior practices that of the general methods used for the separation of galena from sphalerite, only one of them permits the flotation of the sphalerite leaving the galena and silica in the tailings. Consequently, there has been no generally useful method by which the zinc sulphide could be floated in such fashion that commercially satisfactory separations of the zinc sulphide from the lead sulphide could be achieved. This has been due, most probably, to the dearth of flotation agents which would preferentially float the zinc sulphide.

We have now discovered a class of flotation agents which will effect a remarkable separation of zinc sulphide from lead sulphide in ores containing the same, and our flotation agents preferentially float the zinc sulphide. The flotation agents of the present invention are primary aliphatic amines having at least six carbon atoms, or water-soluble salts thereof. These amines, include hexylamine, octylamine, decylamine, dodecylamine, tetradecylamine, hexadecylamine and octadecylamine. The most generally used corresponding water-soluble salts are the hydrochloride and the acetate. Mixtures of such amines are especially suitable since they can be prepared readily from the corresponding fatty acid mixtures by first converting the fatty acids to nitriles and then hydrogenating the nitriles. Such fatty acid mixtures are those found as triglycerides in the common fats and fatty oils from which they can be obtained in well known ways. The unsaturated primary aliphatic amines are also useful, and many of the mixtures of amines we would use include unsaturated amines, as well as saturated. Thus, for example, that amine mixture prepared from the fatty acids of cottonseed oil will include amines derived from oleic acid, as well as those derived from palmitic and stearic.

In the practice of our invention we simply subject the ore containing zinc sulphide, lead sulphide and gangue to froth flotation in the usual way in the presence of the amine flotation agents of our invention. No changes are necessary in the mechanical steps of the flotation process. Although our invention is primarily directed to the use of the stated primary amines and their salts, it will, of course, be understood that additional flotation agents can be present, such as the xanthates. But our flotation process works very well when the flotation agent consists only of our amines and their salts. We do not wish to exclude, however, the use of other agents in admixture with our amines.

We shall now give examples of how our invention may be practised.

Example 1

An ore containing galena and sphalerite (lead sulphide and zinc sulphide) and analyzing 42.25% lead and 37.42% zinc was made into an aqueous pulp in the usual way and floated in a Denver type flotation cell with an amount of dodecylamine equivalent to 0.35 pound per ton of ore. The pH of the pulp was adjusted to 8.4 by the addition of sodium hydroxide solution. The ore subjected to flotation amounted to 476.60 parts by weight. After performing the flotation operation we obtained a concentrate amounting to 220.91 parts by weight and which analyzed as follows: lead, 7.34%; zinc 62.26%. The tailings amounted to 255.69 parts by weight and contained 74.33% of lead and 9.50% of zinc. The

distribution of the lead and zinc, therefore, is as follows: zinc, 84.99% in the concentrate and 15.01% in the tailings; lead, 74.33% in the tailings and 7.86% in the concentrate. This gives a selectivity index of 8.9.

Example 2

A mixture of galena and sphalerite amounting to 472.82 parts by weight was placed in a Denver type flotation cell along with water and the equivalent of 0.25 pound per ton of amines added. These amines were prepared by the hydrogenation of nitriles which had been made from coconut oil fatty acids. They thus contained amines corresponding to oleic acid, palmitic acid and others. The original galena-sphalerite mixture had 43.35% of lead and 36.12% of zinc. After froth flotation we obtained a concentrate which weighed 260.13 parts by weight and analyzed 3.55% of lead and 65.65% of zinc. The tailings amounted to 222.69 parts by weight and contained 83.14% of lead and 3.07% of zinc. The distribution of the lead and zinc was, therefore, as follows: lead, 95.24% in the tailings and 4.25% in the concentrate; zinc, 96.16% in the concentrate and 3.84% in the tailings.

Example 3

A sample of the same galena and sphalerite mixture described under Example 1 was floated with 0.50 lb. per ton of octadecylamine acetate. The distribution of the lead and zinc was as follows: lead, 89.01% in the tailing and 10.99% in the concentrate, zinc, 88.23% in the concentrate and 11.77% in the tailing.

Example 4

A lead-zinc ore amounting to 478.59 parts by weight was floated in a Denver type flotation cell with the equivalent of 0.15 lb. per ton of ore of dodecylamine. The ore analyzed as follows: SiO_2, 30.24%, Pb, 36.70%, and Zn 16.85%. This flotation procedure resulted in a concentrate which amounted to 154.75 parts by weight and analyzed as follows: SiO_2, 7.40%, Pb, 14.75%, and Zn, 48.85%. An additional amount of dodecylamine corresponding to 0.16 lb. per ton of ore was added to the cell and the mixture floated. This resulted in a second concentrate which amounted to 141.18 parts by weight and which contained 58.95% SiO_2, 28.92% Pb, and 4.40% Zn. The tailings amounted to 182.66 parts by weight and had the following composition: SiO_2, 28.11%, Pb, 60.76%, and Zn 0.64%.

Based on these resulted the distribution of the various ore values was as follows: silica, 7.84% in the first concentrate, 55.51% in the second concentrate, and 36.65% in the tailing, lead, 12.98% in the first concentrate, 23.81% in the second concentrate, and 63.21% in the tailing, zinc, 90.87% in the first concentrate, 7.69% in the second concentrate, and 1.44% in the tailing.

The foregoing examples illustrate the use of dodecylamine, mixtures of amines, and octadecylamine acetate. Similar results are obtained when other primary amines and mixtures thereof, as well as their water-soluble salts are used, provided the amines have at least six carbon atoms. So far as we are aware we are the only ones who have satisfactorily separated zinc sulphide as a concentrate from lead sulphide in ores containing the same using such small amounts of flotation agents and without any previous treatment of the ore other than that of grinding it and admixing it with water. One of the great advantages in our process is that the flotation can be conducted on the acid or alkaline side as desired, and, consequently, there is no necessity for a careful control of the pH value of the ore pulp.

Having thus described our invention, what we claim is:

1. The process of separating zinc sulphide from lead sulphide in ores containing the same, which comprises subjecting an aqueous pulp of the ground ore to froth flotation in the presence of an amine compound chosen from the group consisting of unsubstituted primary aliphatic amines containing at least six carbon atoms and water-soluable salts thereof.

2. The process as in claim 1 wherein the amine is dodecylamine.

3. The process as in claim 1 wherein the amines consist of a mixture of amines prepared from mixtures of fatty acid acids having at least six carbon atoms.

4. The process of separating zinc sulphide from lead sulphide in ores containing the same, which comprises subjecting an aqueous pulp of the ground ore to froth floation in the presence of a mixture of unsubstituted primary aliphatic amines obtained by hydrogenating cocoanut oil fatty acid nitriles.

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