



Lead-Zinc ores

Flotation separation and recovery of lead and zinc concentrates from ores containing galena (PbS) and sphalerite (ZnS) is well established and generally achieved quite effectively. Silver often provides highly significant economic value, if not the greatest value, with the silver most often associated with the galena mineralization which is fortuitous since smelters pay more for silver in lead vs. zinc concentrates. The non-values include iron sulphides such as pyrite and pyrrhotite that, while are often floatable, can be controlled. Siderite, an iron carbonate mineral, is often also associated in at least some minor quantity.

Marmatite ((Zn,Fe)S) is an iron-rich sphalerite which consequently results in lower zinc concentrate grades. Marmatite concentrates have a lower zinc level due to dilution from the iron minerals.

Separations are made possible by galena's inherent natural hydrophobicity and due to the fact that sphalerite as a mineral is not easily collected by flotation reagents. The well established two stage sequential flotation process is employed:

-  An important first step entails ensuring the sphalerite surface is not activated with dissolved metal ions, which then makes the sphalerite non-floatable. The established lead-zinc ore flotation processing scheme is to add zinc sulphate (ZnSO₄) to the grind to control metal ion activation (sphalerite depression). Often metabisulphide or other sulphidation chemicals are added with the zinc sulphate for iron sulphide mineral depression.
-  Lead flotation collectors and frother are conditioned before lead flotation which is conducted typically at near neutral to slightly elevated pH which can be increased in the cleaner circuit to ensure iron sulphide rejection. Sometimes cyanide, if can be used, is added to help depress iron sulphides. Because silver typically is mineralogically associated with galena, most of the silver values are carried with and report to the galena concentrate.
-  Sphalerite that is rejected into the lead flotation tails is then floated in a second flotation step after activation with copper sulphate. The copper ions replace zinc atoms on the sphalerite surface creating a pseudocopper mineral surface coverage on the sphalerite which is then collected using copper flotation type collectors. Because most of the iron sulphides also report to the lead flotation tails and so feeds the zinc flotation circuit, typically lime is used to raise pH for iron sulphide depression. The flotation collectors used in sphalerite flotation tend to be less powerful because sphalerite at this stage typically readily floats and using a more aggressive collector can float more non-sphalerite minerals.

Optimum lead concentrate metallurgy and recoveries are usually achieved using a combination of a xanthate and dithiophosphates. If the galena surfaces are slightly oxidized ("tarnished"), including mercaptobenzothiazole (MBT) is often made part of the collector suite to maximize galena recoveries. Frothers used in galena flotation tend to be of the weaker type, such as MIBC, because galena is readily floatable and have high flotation kinetics. However, because of the high float kinetics and high galena mineral density, the mineral froth carrying capacity may necessitate use of a slightly stronger frother or a combination with a stronger frother component for achieving optimum metallurgical results.

Normal sphalerite flotation practice is to raise flotation pH to 10-12 for enhancing the rejection of iron sulphide minerals to the sphalerite flotation tails. Many operators prefer to use an alcohol type frother in sphalerite flotation to maximize sphalerite flotation selectivity. A lower molecular weight xanthate such as sodium isopropyl xanthate (SIPX) is used in combination with a less powerful dithiophosphate flotation collector, and in rare cases, a thionocarbamate flotation reagent.

In rare circumstances, mineralogy and metallurgical response considerations necessitate an initial bulk lead-zinc concentrate with the lead and zinc minerals subsequently separated in a selective flotation step. Under this scheme, a bulk galena and sphalerite flotation concentrate is produced at pH 6.5 (modified with H₂SO₄) with some copper sulphate addition to ensure full sphalerite activation. The bulk concentrate is subsequently conditioned with sodium hydroxide to achieve an approximate 11.5 pH and collector addition from which a lead concentrate is floated. The zinc concentrate is actually the tails from this bulk separation step. The flotation tailing is the zinc concentrate. If the silver is associated with the galena, the silver reports to the lead concentrate.

While pyrite is fairly easy to depress with lime, pyrrhotite is more difficult to depress. An alternative to metabisulphide depression is to aerate the slurry which, if the pyrrhotite is reactive, can render this iron sulphide less floatable. In cases of greater iron sulphide depression challenges, the zinc concentrate can be cleaned by reverse flotation of the concentrate by first treating with SO₂ to reduce pH to 5-5.5 and then heating the pulp to 60-70 degrees C. The gangue is floated with the sphalerite reporting to the tails.

The following Danafloat™ collectors are to be considered most relevant for the lead-zinc flotation:

Selective Pb Float:

Danafloat™ 067
 Danafloat™ 068
 Danafloat™ 070
 Danafloat™ 271, 571 for tarnished or oxidized lead.

Selective Zn Float:

Danafloat™ 123
 Danafloat™ 233
 Danafloat™ 468
 Danafloat™ 245
 Danafloat™ 271
 Danafloat™ 571