

This invention relates to the treatment of ores and products containing copper and iron, in conjunction with the combined leaching and electrolytic treatment of ores and products containing zinc.

My improved process is carried out in a manner and with apparatus very similar to my former process, as described in detail in the specification of previous Letters Patent, dated the 20th day of June, 1894, No. 6914, and the 18th day of October, 1895, No. 7985.

The essential improvements now made consist in working in conjunction with the zinc-bearing ores and products other ores and products, especially products containing copper and iron, such as are obtained from iron- and copper-pyrites or sulphide ores by means of the preliminary furnace-treatment almost universally employed in the treatment of such ores.

These products—viz., copper and iron mattes, regulus, or crude copper—can, by the method under review, be employed as a substitute for a portion of the iron anodes required in my process above referred to, and in such employment, while effecting an economy in the treatment of the zinc-bearing ores, are themselves cheaply treated for the recovery of their valuable constituents.

In carrying this improved process into effect I operate in a similar manner, and with similar apparatus, and with the same solutions as in the former patented process, with the exception that I substitute for the iron anodes (either entirely or partially) anodes consisting of the iron- and copper-bearing mattes, regulus, or crude metal above mentioned. The metals in this material may occur in various proportions to each other, but it is immaterial for the purpose of this invention what those proportions are, except in so far as may be determined by economical considerations.

In operating with anodes of this description, the gold, silver, and sulphur of the anode are set free in solid form, while iron and copper are imparted to the solution in amounts depending on the composition of the anodes. Whilst the products of the electrolysis of the anodes are being dissolved as in the formerly-patented process, pure zinc is being deposited at the cathode as before. The copper imparted to the solution may be removed therefrom by electrolysis, and ferrous salts contained in another batch of the solution may in such electrolysis be simultaneously raised to the ferric state, the electrolysis being performed in vats having insoluble anodes and copper cathodes separated by diaphragms. The copper thus produced is refined copper, and the ferric-salt solution is regenerated leaching-solution suitable for leaching zinc-bearing ores.

It will be seen that cathodes of other conducting materials than copper may be used if desired. In certain cases it may be preferred to take the whole or a part of the copper out of the solution by the simple contact of metallic iron (known as the cementation method), in which case an equivalent of iron is dissolved for the copper precipitated. In other cases copper may be deposited at the cathode whilst metallic iron anodes become dissolved, and the superabundant electromotive force then developed may be usefully employed to aid the operation of depositing zinc by connecting such vats in the same electrical circuit as the vats wherein the zinc is deposited. In cases where pure zinc is to be deposited it will be necessary to employ diaphragms, but in certain cases where products of convenient composition are being operated upon diaphragms may be dispensed with, and the proportion of the different metallic salts in solution may be maintained sufficiently constant to insure a uniform product—viz., an alloy of the different metals of a uniform composition.

It is unnecessary to more minutely describe the methods herein explained, as they will be readily understood by any person properly versed in the art to which they appertain on reference to the former patent referred to; but to facilitate reference I here incorporate certain portions of the previous specification.

The operation of leaching the zinc-bearing ore or product is the same as before—that is to say, the ore, if it contain zinc-sulphide, is first subjected to an oxidizing roast, whereby the zinc-sulphide is converted as far as possible to neutral or basic zinc-sulphate and zinc-oxide; any lead-sulphide contained also undergoing oxidation more or less completely. In the case of ores or products containing zinc only in the form of oxide, such roasting will be unnecessary.

The ore or product having been ground to extreme fineness (which may be done either before or after roasting) is then subjected in properly-proportioned quantity to the action of a leaching solution containing ferric salt, as hereinafter specified, the reaction between the finely-ground ore or product and the solution being promoted by maintaining the same in a constant state of agitation by stirring or otherwise, this operation being continued for from half an hour to two hours, and the proportional quantity of ore and solution being so calculated that the reaction with all the iron-salt in the solution will be complete when so much zinc has been extracted from the ore that the residue left is of good composition for subsequent smelting. For instance, with ores containing 30 per cent. of zinc probably some 5 per cent. would be allowed to remain in the residues, on account of the higher cost of total extraction. The solution, after being separated from the residues, may contain a small quantity of silver, gold, copper, antimony, arsenic, manganese, alumina, silica, and other foreign matters taken from the ore, also a small quantity of iron in the form of soluble ferric hydrate, which foreign matters I prefer to remove by well-known means before subjecting the solution to electrolysis.

The solution, having been brought to the condition indicated, is now to be treated in the zinc electro-depositing plant, where the zinc is recovered, and the solution is recharged with ferric salts, so as to render it fit for use again in the above-described operation of leaching.

The electro-depositing apparatus consists essentially of a number of depositing-vats provided with anodes of copper and iron, and suitable cathodes (preferably zinc plates), and a number of similar vats having anodes of insoluble material, such as carbon, the total depositing-capacity of the plates in the iron-anode vats being about twice that of the carbon-anode vats. Diaphragms of porous material are placed between the anode and the cathode plates, so as to divide each vat into a number of separate cells permitting the passage of the current without allowing the intermingling of the liquids.