United States Patent Office

3,081,163

Patented Mar. 12, 1963

3,081,163

TREATING COPPER MATTE

Charles R. Kuzell, Phoenix, Morris G. Fowler, Douglas, Leonard Klein, Scottsdale, and George S. Hawkins, Douglas, Ariz., assignors to Phelps Dodge Corporation, New York, N.Y., a corporation of New York

Filed Mar. 8, 1960, Ser. No. 13,593
8 Claims. (Cl. 75—75)

This invention relates to pyrometallurgy and, in general, to recovery of copper and iron from ores or other compositions containing these elements. More particularly, it relates to pyrometallurgical treatment of iron-containing copper matte in a copper converter in which the iron in the matte is separated from the copper in a condition in which it may be subjected to further treatment to recover the iron in metallic form, and the copper is recovered in a form which may, if desired, be subjected to further refining in conventional ways. Most particularly, it relates to the production of an iron source material for the recovery of the metallic iron in the form known as "sponge iron."

For present purposes sponge iron may be considered to be the metallic product resulting from the chemical reduction of iron oxide by reducing agents at temperatures below the fusion point of iron or of any eutectic mixture in impure material containing such iron oxide. The removal of chemically combined oxygen from the lattices of iron oxides accounts for the skeletal form of the final product, which accounts for the name "sponge iron."

In the pyrometallurgical refining of copper ores it has heretofore been common practice to produce a molten copper matte. This is done in a blast furnace, reverberatory furnace or other suitable furnace. In almost all instances the copper matte is converted to copper by a bessemerizing or air-blowing process in a converting vessel. It has been common practice in this air-blowing process to produce a basic silicate slag in which most of the iron collects in the form of the orthosilicate of iron. In accordance with our invention, the copper matte is treated in the converter in a manner different from prior practice and most of the iron is drawn from the converter in oxide form in which it has been rendered suitable for further treatment to recover the iron in metallic state and particularly as sponge iron.

The converter vessels now in most common use for treating copper mate are of the rotating type of cylindrical steel shell lined with a refractory in the form of basic or neutral type brick. That is, a copper converter is conventionally lined with a refractory brick made from a basic or neutral refractory material. There is a variation in size of the copper converters but in current practice, the most widely used and "standard" is a shell thirteen feet in diameter and thirty feet in length, lined with basic type refractory and mounted with its cylindrical axis disposed horizontally. One such converter is well-known in the art as the Peirce-Smith type.

The smelterman's concept of the chemical composition and constitution of copper matte is that of a double sulfide of copper and iron or of the two molten sulfides each mutually soluble in the other in all proportions. Such a general concept needs further detailed discussion for a clearer understanding of our invention. For even though copper matte does consist in the main of the sulfides of copper and iron it also contains significant amounts of oxides of iron. There is a considerable amount of evidence to show that copper matte of any commercial grade (that is, containing sufficient percentage of Cu to make commercial recovery economically feasible) can contain (to the extent of several parts per hundred) magnetic oxide of iron (Fe_3O_4) which is usually referred to as "magnetite." This evidence also indicates that the lower grade mattes can contain appreciable amounts of ferrous oxide (FeO) which for convenience of description we have chosen to call or refer to herein by the name "ferra." It is our observation that low grade mattes in the neighborhood of 15% Cu can contain as much as 15% ferra but the amount of it decreases as the grade of matte increases and disappears entirely in the higher grade mattes. It is not uncommon for the oxides of iron present in the matte to be as much as 15% of the total weight of the matte. As an example, the quantitative chemical analysis of a composite sample of mattes from daily production over a five months' period at one copper smelter with which we are familiar showed 27.2% Cu, 41.7% Fe, 25.2% S, which add up to 94.1%. More detailed analysis and calculation revealed the composition to be as follows:

Ingredient:	Percent of total
Cu_2S	34.0
FeS	49.6
ZnS	0.8
Fe_3O_4 (magnetite)	13.2
FeO (ferra)	1
Miscellaneous minor silicates	1
	100

It will be seen from the above analysis that about one-quarter of the total iron present in the matte exists as oxide as distinguished from sulfide.

It is well known among smeltermen that the conventional process of converting the matte to copper consists in blowing air through the molten matte to oxidize the sulfur and the iron with the production of enough heat to keep the process going without the addition of fuel. The sulfur is eliminated as sulfur dioxide gas which passes out through the chimney. The iron is oxidized and combines with siliceous flux which has been added to form a basic silicate slag called converter slag which is recycled back to the matte producing furnace for retreatment, cleansing and final disposal as a reverberatory or blast furnace slag of higher silicate degree. This slag is ultimately transported to a dump as waste. Consequently, the iron which was present in the copper ore is not recovered but is ultimately transported to a dump in the form of a higher silicate slag, a state unfavorable for the purpose of recovering the iron or for the production of metallic iron as sponge iron.

In contrast, our process produces a magma in the copper converters in which the iron collects, not as a siliceous slag or silicate of iron, but rather as a combination of iron oxides, primarily in the form of FeO (ferra) and Fe_3O_4 (magnetite) which contains only a small amount of silicate but not so much silicate that the magma produced by us in the converter is not amenable to granulation or comminution and further treatment with a reducing gas to produce sponge iron. The magma produced by us is herein called "ferramag" so that it may, for purposes of description, be distinguished from the term "slag" which distinguishes the basic silicate slag produced in a copper converter in conventional practice. According to the most widely accepted concept among