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METHOD OF TREATING ZINC SLAGS

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This invention relates to the recovery of zinc as metallic zinc vapors from zinciferous materials such as silicate zinc slags which result from the smelting of copper or lead ores or from scrap materials containing zinc. More particularly the invention relates to recovery of zinc and other metallic values from ferruginous silicate slags.

The invention provides a process for the recovery of zinc and other metal values from slags which may be advantageously practised in an electrically heated furnace wherein the slag, containing zinc in oxide form, is maintained in a layer superimposed on a bath of molten iron containing dissolved carbon in controlled amount, such dissolved carbon reacting with the zinc oxide in the slag to form zinc metal vapor and also reacting with the oxides of copper, tin and lead, if present, to reduce these to metals so that these metals may be recovered from the slag.

If a ferruginous silicate slag containing zinc in the form of a combined zinc oxide silicate, and which may also contain other metals such as copper, tin and lead, is brought into contact with molten iron containing carbon under proper conditions, the carbon will reduce the zinc oxide to zinc which at the temperature of molten iron will rise above the bath as zinc vapor. Lead, if present, will also reduce to metal, some of which will volatilize and pass off with the zinc vapor. Copper and tin, if present, will be reduced and being less volatile will enter into the iron bath. To carry out these reactions so that the metal values can be recovered in a practical and economical way from silicate slags containing them presents a number of difficulties.

If the original concentration of carbon in the iron is in excess of the amounts required to reduce the zinc in the ferruginous slag (and copper, lead and tin, if present), iron oxide will also be reduced from the slag and will continue to be reduced to very low concentrations of carbon dissolved in the iron. All of these reactions are endothermic and proceed with great rapidity so long as the slag and molten iron are maintained at a temperature conducive to the reaction. But unless the heat input is carefully controlled to supply the proper amount of heat, the endothermic reaction proceeds at such rate that the iron bath and slag in the furnace become chilled with the result that the slag becomes pasty, gas generated by the reaction can not escape as rapidly as formed, and the slag will "foam" out of control. Even if enough heat can be forced into the furnace, to avoid the chilling effect of the endothermic reactions, in the presence of excess carbon, the iron oxide in the slag will be excessively reduced, and the slag will become too highly siliceous.

Although there has been a proposal in the prior art to recover zinc from ferruginous slags containing zinc by flowing the slag over a molten iron bath in an electrofurnace, the principle upon which that process is based is that the iron in the bath reacts with the zinc oxide in the slag to reduce it to zinc with a corresponding production of iron oxide which enters the slag, this iron

oxide then being reduced to iron in another part of the furnace by the addition of coke breeze to the slag; the reduced iron then re-entering the iron bath. In such process the zinc oxide is to be reduced solely by iron from the bath and no effort was made to reduce the zinc oxide in the slag by carbon dissolved in the molten iron bath and what is perhaps even more important is that workers in this field heretofore did not recognize the significant factor of mol ratio of FeO to SiO_2 in the slag.

According to my invention ferruginous slag containing zinc is treated in an electric furnace in which the furnace temperature and the reactions are controlled so that substantially all zinc in such a slag is reduced to zinc vapor; and copper and tin, if present, are carried into the iron metal bath from which they may be readily recovered; the zinc oxide and the other non-ferrous metals, such as copper, tin and lead, in the slag being reduced by reaction with carbon dissolved in controlled amount in the molten iron.

According to one method of employing the process of my invention, a thin layer of slag is maintained, either as a batch treatment or as a continuous or semi-continuous flow, over a relatively deep bath of molten iron in a suitable furnace. Carbon is introduced into the molten bath preferably without contact between the introduced carbon and the slag. The carbon dissolves or goes into solution in the iron bath and in that dissolved form becomes spread or diffused through it. Thus the carbon comes into contact with the slag in the form of a dilute solution of carbon in iron. The rate of the reaction between the dissolved carbon and zinc oxide, forming carbon dioxide and carbon monoxide gas, is governed by the concentration of the carbon dissolved in the iron metal bath and the concentration of zinc oxide in the slag and also other metallics to be recovered, such as copper, lead and tin, if present. Also, the rate of reaction between the carbon dissolved in the iron bath and the iron oxide present in the slag is affected by the concentration of carbon in the molten iron. The concentration of carbon in the iron bath is controlled or adjusted so that it will not rise to a point where the rate of endothermic reduction of oxides in the slag is greater than the rate of heat input to the furnace and sufficient carbon is added to the iron as the endothermic reducing action proceeds to reduce the zinc oxide in the slag to zinc vapor; and if copper, tin and lead oxides are present, sufficient carbon is added to reduce these to metals and also to reduce a predetermined amount of iron oxide in the slag to iron metal.

The temperature maintained in the furnace must be above the melting point of the iron bath. The melting point of pure iron is generally given as 2786° F. which is, of course, lowered by alloying impurities. Generally speaking, a temperature of the order of 2750° F. to 2800° F. will suffice to keep the iron safely molten. While it is possible to raise the furnace temperature higher than this, it is not usually advisable because of the corrosive tendencies of slag at very high temperatures. The furnace temperature should not be lowered below the melting point of the iron bath.

The amount of carbon to be added to the molten iron can be calculated very closely or exactly if the exact analysis of the slag and the exact temperature of the bath are known. If the slag being treated is one which does not contain material quantities of recoverable non-ferrous metals other than zinc; that is, if the slag contains zinc oxide and no copper, tin or lead, the amount of carbon added to the molten iron bath is that amount which will react with the zinc oxide. In this case the mol ratio FeO/SiO_2 in the slag preferably is not varied. In other words, none of the iron oxide in the slag is reduced and