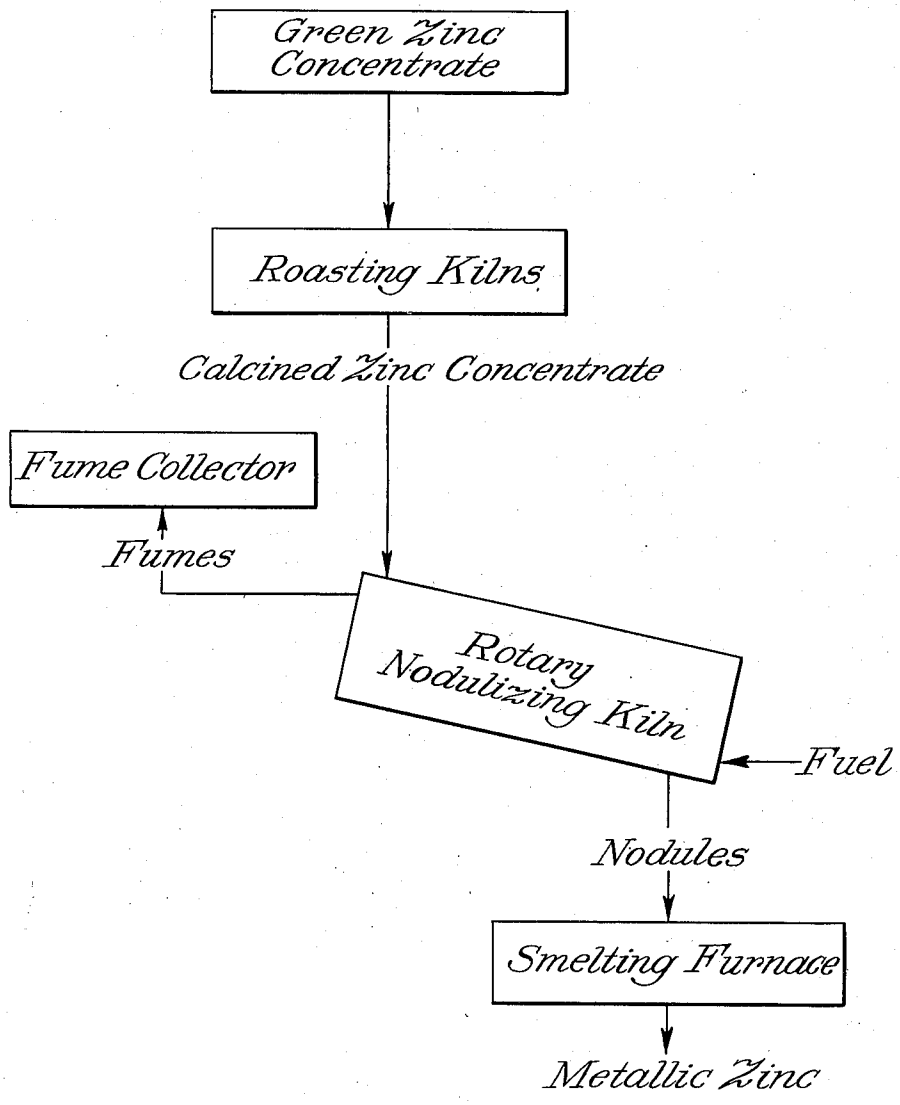
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METHOD OF REFINING ZINC ORE

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METHOD OF REFINING ZINC ORE

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The present invention relates to a method for the recovery of zinc from a zinc concentrate.

In general, the production of zinc from a zinc concentrate may be accomplished by roasting, followed by sintering and furnace reduction, or by electrolysis, in which case the electrolysis is carried out after a special roasting step. The type of process used, in general, determines the quality of the zinc produced, the electrolytic method producing predominantly "High Grade" zinc, and the other methods producing the lower grade products.

The commercial zinc on the market is graded as follows:

Grade	Percent Zinc
High Grade	99.5–99.8
Intermediate	99.35
Brass Special	98.7
Prime Western	98.0

The standard specifications for slab zinc of the various grades is indicated below:

Grades	Percent (Max.)			
	Pb	Fe	Cd	Sum of Pb, Fe, Cd
High Grade	0.070	0.020	0.070	0.100
Intermediate	0.200	0.030	0.500	0.500
Brass Special	0.600	0.030	0.500	1.000
Prime Western	1.600	0.080	-------	-------

The electrolytic method, while in general producing the highest grade zinc, has the disadvantage of relatively high operating cost.

In all methods of zinc production one of the prime considerations is the conversion of the zinc sulfide present in zinc concentrate to the oxide, since the presence of the sulfide is not desirable, and is even harmful, in the final distillation step for the recovery of the substantially pure zinc. Consequently, it has been the general practice to reduce the sulphur content of the ore or concentrate to between about 3% and 7% by roasting, followed by sintering, which further reduces the sulphur content to a minimum prior to the distillation step.

In the well known Waelz process, zinc residues and other zinc-bearing materials are treated with a solid carbonaceous reducing agent in a horizontal, rotary kiln, where the materials are dried and heated by the hot gases. A strong reducing atmosphere within the charge frees the metals,

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which are volatilized in the process. An oxidizing atmosphere, maintained above the charge in the kiln, then oxidizes the escaping metallic vapors as well as the carbon monoxide. The fumes and gas from the kiln are treated in a bag house or by Cottrell precipitators to recover a predominantly zinc oxide product which may be subsequently distilled in a conventional retort furnace to produce metallic zinc.

In another process, sufficient sulphur is removed by roasting a zinc sulfide ore to bring the roasted ore to a sulphur content of 4% or less, the resulting zinc oxide is then treated with a carbonaceous reducing agent together with a chloridizing agent such as sodium chloride for the elimination of cadmium, lead and sulphur, and the resulting sintered cake, alleged to be a substantially pure zinc oxide cake, is subsequently distilled in a furnace.

An object of the present invention is to prepare zinc metal in a quality heretofore unobtainable in the normal retort smelting process.

Another object of the present invention is to prepare a high quality zinc without the necessity of adding solid carbonaceous reducing agents or chloridizing agents prior to the distillation stage.

Another object of the invention is to provide a process for the manufacture of high quality zinc providing for better zinc furnace recovery and lower cost in the smelting operation.

Another object of the present invention is to provide a process for the production of high quality metallic zinc while utilizing a relatively high sulphur content zinc concentrate.

Still another object of the invention is to provide a method for treating zinc concentrates whereby the normal impurities such as cadmium and lead may be recovered as valuable by-products.

We have found that these objects may be obtained by subjecting a zinc sulfide concentrate to a preliminary roasting operation to reduce the sulphur content to within the range of from about 5% to about 10%, forming what is known as a calcined zinc concentrate, nodulizing the resulting zinc concentrate in a rotary kiln, and reducing the zinc oxide nodules in a conventional retort furnace.

By reducing a high sulphur content concentrate, normally containing between 28% and 30% sulphur to a sulphur percentage of 5 to 10, as compared with the range of between about 3% to 7% as in normal practice, a considerable saving in roasting cost is effected. We have found that when a calcined zinc concentrate contain-

ing from about 5% to about 10% sulphur is nodulized as in a rotary kiln, the nodules produced have a high apparent density, yet also a high porosity, and may be treated in a conventional furnace to give a zinc metal of a quality heretofore unobtainable by the normal retort smelting process. Where the preliminary roasting is carried out to yield a calcined zinc concentrate containing less than 5% sulphur, an amount of high sulphur content green concentrate may be added to bring the sulphur content into the desired range. The feed to the nodulizing kiln may be wet or dry and may have practically any particle size.

More specifically, the calcined zinc concentrate from the pre-roasting process is passed through a rotary kiln which consists essentially of a refractory-lined tube which rotates about its longitudinal axis, the axis being inclined at a slight angle to the horizontal. In the lower end of the kiln, one or more fuel burners, utilizing gas, powdered coal or oil, are arranged for furnishing heat to the contents of the kiln. An excess of oxygen over that theoretically required to oxidize the sulphur present is maintained in the nodulization kiln. The rotary motion of the kiln tends to completely or substantially agglomerate the fines present in the feed stock, forming nodules ranging in maximum dimension from a fraction of an inch to several inches. The nodules, containing a high percentage of zinc oxide, leave the rotary kiln at its lowermost portion and are then preferably cooled. The nodules in heated condition are extremely tough, but by cooling the nodules, they are made more susceptible to crushing to obtain properly sized material for introduction, after mixing with the reducing agent, into the retort furnace.

In the rotary kiln, substantially all of the cadmium and sulphur, and most of the lead, are volatilized, but only a very minor proportion of the zinc present is volatilized. The volatilized metals are recovered in collection apparatus such as bag houses, Cottrell precipitators, cyclone separators, and the like. The treatment in the rotary nodulizing kiln eliminates substantially all of the sulphur content of the original charge as sulphur dioxide.

Normally, only a small amount, as low as 1%, of the zinc originally present in the charge is volatilized in the nodulizing furnace, but even this small amount may be recovered in the precipitation apparatus.

The nodules leaving the rotary kiln are characterized by relatively high apparent density, on the order of from about 137 to about 189 pounds per cubic foot, and an apparently uniform porosity, normally about 15%. The percentage porosity is determined by measuring the actual density and the apparent density, subtracting the latter from the former, and calculating the percentage of the actual density represented by the difference. The high density permits increased retort or other type zinc furnace capacity with consequent lower cost in the smelting operation. The high porosity of the particles permits better zinc furnace recovery due to the intimate contact of the zinc with the reduction agents within the furnace, whether solid or gaseous reducing agents are used.

Reaction conditions within the nodulizing kiln may be varied over a considerable range depending on the percentage of sulphur in the calcined zinc concentrate used as the feed material. In general, the temperature within the kiln is on the order of about 2,000 to 2,300° F. when the sulphur content of the calcined zinc concentrate is in the range from about 5% to about 10%.

An excess of air is essential in the operation of the rotary nodulizing kiln to maintain an essentially oxidizing atmosphere within the kiln. Reduction of the amount of air in the kiln causes increased volatilization of zinc, which is highly undesirable. The proper amount of air, as well as the proper temperature, to be used may be determined by observation of the kiln operation. The air supply and temperature are adjusted so that any substantial burning of zinc, evidenced by a green flame within the kiln, is avoided.

The nodules leaving the rotary kiln are cooled and crushed, roughly to ¼ to $\frac{3}{16}$ each in size, for admixture with a reducing agent in the retort furnace, as hereinbefore mentioned.

The resulting crushed nodules may then be reduced in a conventional retort furnace by means of the customary reducing agents.

We have found that the slab zinc resulting from a reduction of the nodulized material results in a higher quality product that has been previously obtained in normal retort operation. For example, a typical analysis of a slab zinc prepared from nodulized material by our process shows 0.014% iron, 0.05% lead and a trace of cadmium, leaving a zinc content of approximately 99.9%. This product is well within the specifications for premium quality High Grade zinc. The major proportion of the zinc produced by this process would classify either as intermediate or as High Grade, whereas zinc produced by the normal sintering and furnacing processes yields essentially Prime Western and Brass Special grade zinc, when using normally available zinc concentrates.

It can be seen that the invention provides a process for the production of high quality zinc from a calcined zinc concentrate, with or without the addition of high sulphur content green zinc concentrates. The process is applicable to a wide variety of zinc concentrates and to the use of such concentrates in either wet or dry condition. The product of the nodulizing furnace has a relatively high density yet has also a uniform high porosity, making it particularly amenable for reduction in a retort furnace. The process itself permits continuous uninterrupted operation of the nodulizing step, with only a small measure of mechanical maintenance being required. There is no substantial generation of noxious fumes and an almost total absence of dusting, thus providing excellent working conditions for the operating personnel.

A specific example of the process of the invention will be described with reference to the attached flow diagram.

A green zinc concentrate composed largely of zinc sulphide and analyzing 60% zinc, 32% sulphur, 0.3% cadminum and 1.0% lead is charged into a roasting kiln wherein the green zinc concentrate is partially oxidized. The calcined zinc concentrate produced contains approximately 65% zinc, 8% sulphur, 0.33% cadmium and 1.2% lead. This calcined concentrate is next fed to the upper end of an inclined rotary nodulizing furnace which is maintained under substantially oxidizing conditions. The fumes from the nodulizing kiln are collected in appropriate fume collectors for the recovery of cadmium and lead. The resulting nodules leave the lower end of the inclined kiln and contain approximately 71% zinc, 0.05% to 0.08% lead, and traces of sulphur

and cadmium. The nodules have an apparent density of about 137 to 189 pounds per cubic foot.

The nodules, preferably cooled and ground to a size of approximately ¼ inch, and then passed to a conventional zinc smelting furnace to be treated with appropriate reducing agents. The slab zinc recovered from this furnace contains about 0.05% to 0.10% lead and only a slight trace of cadmium.

Many modifications may be made in the process herein described without departing from the spirit of the invention, and it is not our intention to limit the scope of the invention otherwise than necessitated by the scope of the appended claims.

We claim as our invention:

1. The process for the recovery of zinc from a sulphur-containing zinc ore, which comprises simultaneously tumbling and heating a zinc ore product containing from about 5% to 10% of sulphur at a sintering temperature of from 2000 to 2300° F. in the absence of solid carbonaceous material and in the presence of an amount of oxygen in excess of that stoichiometrically required to oxidize the sulphur present to sulphur dioxide, continuing the tumbling and heating until substantially all of the sulphur, cadmium, and most of the lead have been volatilized and recovering a sintered product containing zinc oxide and not over about 0.08% of lead and only a trace of cadmium, said product being in the form of nodules of substantially uniform porosity that are particularly amenable after being ground for reduction in a retort furnace to recover high quality metallic zinc therefrom.

2. The process for the recovery of zinc from a calcined zinc concentrate produced by the roasting of a high sulphur-containing zinc ore, which comprises subjecting a mass of such calcined zinc concentrate containing initially from about 5 to 10% by weight of sulphur to a rotating and tumbling action, simultaneously with such action heating said calcined zinc concentrate to a sintering temperature of from 2000 to 2300° F. in the absence of solid carbonaceous material and in the presence of an amount of oxygen in excess of that stoichiometrically required to oxidize the sulphur present to sulphur dioxide, continuing the rotating, tumbling and heating until substantially all of the sulphur, cadmium, and most of the lead have been volatilized and recovering a sintered product containing zinc oxide and not over about 0.08% of lead and only a trace of cadmium, said product being in the form of nodules of substantially uniform porosity that are particularly amenable after being ground for reduction in a retort furnace to recover high quality metallic zinc therefrom.

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