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METHOD OF TREATING SILICIOUS ORES.

1,305,327. Specification of Letters Patent. Patented June 3, 1919.

No Drawing. Application filed February 7, 1918. Serial No. 215,801.

To all whom it may concern:

Be it known that I, GEORGE H. WIGTON, a citizen of the United States, residing at Eureka, in the county of Juab and State of Utah, have invented certain new and useful Improvements in Methods of Treating Silicious Ores; and I do hereby declare the following to be a full, clear, and exact description of the same, reference being had to the accompanying drawings, forming part of this specification.

My invention relates to the treatment of silicious ores, and particularly to the treatment of such ores which contain large amounts of base chloridizable metals.

The object of the present invention is to provide a process of treatment of silicious ores in which the usual difficulties due to the stickiness and the clinkering of the furnace charge is obviated.

A further object is to reduce the cost of obtaining the metal content of silicious ores containing large amounts of chloridizable metals.

In my copending application, Serial No. 121,696, filed September 22, 1916, of which the present application is a continuation in part, I have described a process of avoiding the usual stickiness of the furnace charge of finely ground ore, slag and salt, by maintaining all chloridizable particles of the metal exposed to the current of gas or air in the oxidizing furnace in order to obtain complete volatilization of the metal as a chlorin compound, this being accomplished by so regulating the composition of the mixture that the temperature required for the formation of slag from such mixture is greater than the temperature required for the volatilization of the metal content. This, however, requires that the ore so treated shall be limited to a content of base metal insufficient to cause the formation of a slag in the presence of an excess of an alkaline chlorid at the volatilization temperature of the metallic compound content of the ore.

The present application closely parallels the application just mentioned in that it eliminates the usual furnace troubles caused by the stickiness of the charge, but differs in that the present method, while suitable for such low grade ores is also applicable to ores having high metal content and in fact is more advantageous with such rich ores.

In the process of volatilizing metals from silicious ores by mixing the ore with common salt and applying heat, probably the chief difficulty involved in the operation of the volatilization furnace is the tendency of the charge to form compounds fusible at the furnace temperature. This tendency increases greatly in the treatment of ores containing large amounts of chloridizable metals, and also when a furnace atmosphere high in oxygen or moisture exists. This tendency to fuse causes the charge to lose its granular character, stick to the bottom and sides of the furnace, reduce the volatilization of the metals and restrict the direct application of the process to ores containing the precious and very small amounts of base chloridizable metals.

To exemplify the formation of fusible compounds, the following reactions are shown, in which the Na_2SiO_3 is the fusible compound.

(1) Formation of fusible compounds due to reaction between chloridizable metal, silica, and salt:

$$PbCO_3+2NaCl+SiO_2+heat=PbCl_2+Na_2SiO_3+CO_2$$

(2) Formation of fusible compound due to reaction between oxygen, salt and silica:

$$2NaCl+O+SiO_2=Na_2SiO_3+Cl_2$$

(3) Formation of fusible compound due to reaction between steam, salt and silica:

$$2NaCl+H_2O+SiO_2=Na_2SiO_3+2HCl$$

A number of combinations of the above reactions are possible and probably occur in the furnace, for example,

$$PbCO_3+4NaCl+SiO_2+O=PbCl_2+Na_2O+Na_2SiO_3+Cl_2+CO_2$$

or, if the furnace is high in moisture:

$$2PbCO_3+8NaCl+3SiO_2+O+H_2O=2PbCl_2+Na_2O+3Na_2SiO_3+Cl_2+2HCl+2CO_2$$

As pure Na_2SiO_3 fuses at about the furnace temperature, 1000° C. the cause of the stickiness is obvious.

By the addition to the furnace of limerock, dolomite, or magnesite, bases will be present whose individual silicates melt at a temperature much higher than the furnace temperature. Moreover, if the proper proportion exists between the basic radical derived from the salt and the bases derived

from the limerock, dolomite, or magnesite, a mixed silicate will result, whose fusing temperature is also greater than the furnace temperature. Thus, by the addition of limerock, dolomite, or magnesite, in proper amount to the furnace charge, formerly consisting of ore and salt, a mixture can be obtained which is infusible at the furnace temperature and hence will permit of efficient furnace operation and better extractions by volatilization. This improvement has not only permitted the more efficient treatment of ores containing only small amounts of base chloridizable metals, but has also extended the direct application of the process to ores containing much larger quantities of such base metals.

The limerock, dolomite, or magnesite may be mined along with the ore in case they occur closely associated, or are in close proximity.

Even the addition of slight amounts of limerock, dolomite, or magnesite will decrease the tendency of the charge to become sticky, but for the best results, it has been found that about twice as much (by weight) of limerock, dolomite, or magnesite should be present in the charge as there is salt, although I do not wish to be confined to the addition of any definite amount, as the proportion varies with different ores according to the other bases present.

In carrying out my invention a proportion of metal bearing ore such as a silicious ore containing the lead or other metal as a carbonate is first mixed with the slag from the reducing furnace (hereinafter described) and the proper proportion of limerock, dolomite or magnesite, and passed through the usual series of graduated grinders emerging as a well granulated mixture. This is then passed to the mixer for incorporation with the alkaline or alkaline earth chlorid, usually common salt, and when so mixed is passed through a drier of any preferred construction and then reduced to as fine a pulverulent condition as is possible in a pulverizer of the ordinary type.

For most ores amenable to the process, the total amount of chloridizing agent, such as salt, $CaCl_2$, or a mixture of the two, to be added to the charge will vary from 8 to 10% of the weight of the ore, but this percentage should be increased or decreased slightly according as the quantity of base chloridizable metal increases or decreases. The slag from the later reduction process, which consists essentially of $CaCl_2$, forms therefore a chloridizing agent for the volatilization process.

To obtain the best results, for each base chloridizable metal in the ore, there should be added an amount of limerock, or other alkaline earth compound, equal to the amount of metal multiplied by the ratio of the atomic weight of the metal to the molecular weight of the limerock. Thus for an ore containing 10% lead, there should be present

$$10 \times \frac{207}{100} = 20.7\%$$

limerock to be added.

After this step has been carried out the mixture is subjected to a slow heat under oxidizing conditions in a roaster of any preferred type until it glows with a dull red glow. Volatilization usually is effected at temperatures ranging from 850° to 1000° C., the volatile metal chlorid passing out of the roaster with the gas.

Any preferred method of recovering the volatile chlorid may be employed, for example, the metallic chlorid or fume may be recovered by the well known bag-house treatment, *e. g.*, by permitting the fume and gas from the roaster to pass through woolen bags which catch the solid particles of metal chlorids or chlorin compounds held in suspension in the gas. Or the compounds of metal with chlorin may be separated from the gas in a Cottrell apparatus. The calcine or refuse from the roaster will be found to contain practically no traces of metal.

After the metallic chlorin compounds have been collected, they are mixed with a sufficient amount of a carbonaceous compound, such as ground coal or coal dust, to reduce the reducible metallic compounds to metal, and a proportion of ground limerock, or other alkaline earth carbonate, sufficient to supply a chemical equivalent of the reducible metallic compound. If limerock is used, the resulting slag will be essentially $CaCl_2$, containing about 35% calcium and 60% chlorin, the remainder being composed of minor impurities. The coal dust is used as a reducing agent and the limerock as a flux.

The mixture is then placed in a reducing furnace and heated to a smelting temperature, which may be approximately 800° C. In the furnace the chlorids of metal are converted into bullion, in the present instance, lead bullion, and the slag consisting of an alkaline or alkaline earth chlorid in which practically all of the chlorin is recovered. The slag from the reducing furnace may be used and in fact is intended to be used as the chloridizing agent for the next charge of ore to be treated.

What is claimed is:

1. The method of treatment of silicious ores, which consists in the addition of limerock to the mixture of ore and a chlorin compound to result in a furnace mixture which will stand a higher temperature without clinkering or becoming sticky than would such first mentioned mixture.

2. The method of treating metal bearing silicious ores which consists in adding to

the mixture of ore and a chlorin compound, a mineral containing an alkaline earth metal, in order to secure a furnace mixture that will not clinker or become sticky at the temperature of volatilization of the metal content of the ore.

3. In the process of obtaining metal chlorid fumes from silicious ores by heating the finely ground ore with a compound containing chlorin and subjecting such mixture to sufficient heat to volatilize the metal content of the ore as a chlorid; the step of adding to such mixture a compound containing a metal the silicate of which is infusible at the temperature necessary to volatilize the metal of the ore as a chlorid, whereby clinkering and the formation of slag is prevented.

4. The cyclic process of obtaining the metal content of silicious ores as bullion which consists in the following steps: mixing the ore with slag from the reducing furnace and with a mineral containing the carbonate of an alkaline earth metal; crushing the mixture; adding an alkaline or alkaline earth chlorid, drying; pulverizing; roasting, collecting the fume from the roaster and mixing it with a reducing agent and a flux; heating the mixture to a furnace temperature sufficient to reduce the metal to its free state; recovering the chlorin compounds in the form of a slag; and mixing such slag with the new charge of silicious ore and alkaline earth mineral.

5. The cyclic process of obtaining the metal content of silicious ores as bullion which consists in mixing such ore with slag, a chlorid and a compound containing metal, the silicate of which is infusible at the temperature of volatilization of the metal of the silicious ore as a chlorid; subjecting such mixture to a furnace of sufficient temperature to volatilize the metal of the silicious ore as a chlorid; collecting such chlorid and mixing same with a reducing agent and a flux; heating such mixture in a reducing furnace, obtaining the metal of the silicious ore as bullion; and returning the slag from the reducing furnace to the cycle for mixture with a fresh charge of ore as above.

GEORGE H. WIGTON.