METHOD OF PURIFYING LEAD, TIN, AND LEAD-TIN ALLOYS

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The present invention relates to methods of purifying lead, tin, and lead-tin alloys and particularly for the removal of copper, arsenic, and antimony from lead, tin, and lead-tin alloys.

The object of the present invention is to devise a process for removing copper, arsenic, and antimony from lead, tin, and lead-tin alloys in a simple, inexpensive and thorough manner.

With this object in view the present invention consists in the method hereinafter described and more particularly defined in the claims.

Lead bullion containing precious metals and pig lead obtained from smelting lead ores or concentrates, or from smelting lead-bearing materials, usually contain varying quantities of other metals or impurities, some or all of which have to be removed and to varying degrees of completeness according to the use to which the lead is to be put. Among such metals whose presence is objectionable are copper, arsenic, and antimony, and various methods have been devised for removing these impurities.

Impure and commercial tin often contain substantial amounts of copper, arsenic, and antimony, the removal of all or part of which is essential in order to fit the tin for certain uses.

Lead-tin alloys or white metal alloys, as they are often called, such as solder and bearing metal, often contain substantial amounts of copper, arsenic, and antimony, and for certain classes of uses is necessary that such alloys be practically free from arsenic, antimony, and copper.

According to the present invention the impurities, copper, arsenic, and antimony, may be removed from lead bullion, pig lead, impure or commercial tin, and white metal alloys in a simple, inexpensive and thorough manner by the use of aluminum. Preferably the material to be treated is melted in an open kettle and the temperature raised to approximately the melting point of aluminum and slightly above, say, from 1230°F. to 1240°F. The aluminum is then preferably added in solid condition although it may be added in solid form and thoroughly stirred into the molten material. The copper, arsenic, and antimony combine with the aluminum to form crusts which collect on the surface of the molten metal. The kettle and its contents are then allowed to cool and at intervals during the cooling and while the material being treated is still molten, the crusts are removed and squeezed to extract the lead, tin or lead-tin alloys held therein. In order to remove the last traces of the impurities, the lead, tin, or lead-tin alloy which has cooled and solidified is remelted and raised about 150°F. above its melting point, again stirred and cooled and the remaining crusts removed.

The crusts as removed and while still at a high temperature may be squeezed or pressed in the usual manner to extract the lead, tin, or lead-tin alloys enclosed therein and the metal so obtained added to the main body of the metal. If desired the crusts may be liquated or sweated in the usual manner thereby and the metal obtained added to the main body of the metal. The crusts which have been squeezed or pressed may also be subjected to a subsequent liquation or sweating to obtain an additional yield of the purified metal or alloy.

Instead of removing the aluminum crusts from the purified lead, purified tin, or white metal alloy in the manner previously described, the separation can be accomplished by allowing the aluminum treated metal or alloy to cool to say about 150°F. above the freezing point of the purified metal or alloy and then casting both the aluminum crusts and molten metal or alloy into a pig, slab, or some other form. The metals or alloys after solidification may then be liquated or "sweated" in the usual manner in a furnace of convenient form at a temperature at which the lead, tin, or the lead-tin alloy will melt and separate out from the aluminum containing residues. In some cases the metal so obtained may have to be liquated, or sweated again if a purer product is desired.

In case the purified metal or alloy is separated from the aluminum crusts by squeezing, it may also be desirable to liquate or sweat these crusts, thus removing an additional amount of the purified metal or alloy.

The subsequent treatment of the aluminum crusts, or aluminum bearing residues, may be by any of the usual metallurgical methods of treatment of lead, tin, or lead and tin bearing materials.

The last traces of aluminum may be removed from the purified metal or alloy by a blast of air through the molten metal or alloy, or the use of lead chloride, or by a blast of chlorine for a few moments, or the addition of sulfur or fusible sulfide.

The amount of aluminum required can be determined from a prior analysis of the material to be treated, approximately one pound of aluminum being needed for each pound of copper, or for each two and a half pounds of arsenic; or for each four pounds of antimony. If preferred, a test bar may be cast from time to time from the contents of the kettle, and if the surface of
The reactions which are believed to take place during this purification process are as follows:

1. \( \text{Cu}^{+2} + 2\text{Al} = \text{CuAl}_2 \)
2. \( \text{Al} + \text{As} = \text{AlAs} \)
3. \( \text{Al} + \text{Sb} = \text{AlSb} \)

These examples are merely examples of the compounds which are found. It is probable that other compounds exist between some of these metals.

While the above described process is adapted for the simultaneous removal of all three impurities, namely, copper, arsenic, and antimony, it is obvious that it may be employed to remove only two, or even a single metal such as antimony from the material to be treated, when only one or two of these metals are present, or where the other impurities have been removed by some other process.

The percentage of copper, arsenic, and antimony, in the metal or alloy is of economic importance in carrying out the process. In the case of arsenic and antimony, it was found that the economic limits of these two impurities in lead, tin, or white metal alloys, is about 10 per cent, combined total of arsenic and antimony, as above this the relative amount of aluminum crusts is excessive, and in the case of tin, or lead-tin alloys, which contain above 10 per cent of antimony the combination \( \text{SbSn} \) has a tendency to emulsify the molten metals after the addition of the aluminum. But below 10 per cent. combined total of arsenic and antimony the relative amounts of aluminum crusts which form are not excessive and the treated lead, tin, or white metal alloy is practically freed from copper, arsenic, and antimony, if the treatment is properly conducted. In cases where the combined total of arsenic and antimony are above, say, 10 per cent, it is preferable to dilute these impure lead, tin, or white metal alloy which contains smaller amounts of arsenic and antimony thus obtaining a metal or alloy which contains less than 10 per cent. of arsenic plus antimony.

In case the copper in the material to be treated, say, about 0.3 per cent., it may be more economical to remove a portion or all of the copper by some other means, such for instance, as by the usual method of liquation, either in a furnace or in a kettle. Such preliminary treatment would reduce the amount of aluminum used and also the amount of crusts produced, thereby cheapening the purification method and yielding possibly a higher direct recovery of the purified metal or alloy.

Thus described the invention, what is claimed is:

1. The method of treating lead, tin, and lead-tin alloys to remove the impurities of copper, arsenic or antimony, which consists in melting the lead, tin, or lead-tin alloy and adding aluminum to the molten mixture, stirring and reducing the temperature of the molten material to form crusts containing the impurities, and then separating the molten material and the crusts.

2. The method of treating lead, tin and lead-tin alloys to remove the impurities of copper, arsenic or antimony, which consists in bringing into a state of liquefaction a mixture of lead, tin or lead-tin alloy and aluminum at a temperature not greatly exceeding the melting temperature of aluminum, allowing the molten mixture to cool to cause the alloys of aluminum with the impurities to form in crusts, and separating the crusts from the purified metal.

3. The method of treating lead, tin, and lead-tin alloys to remove the impurities of copper, arsenic or antimony, which consists in melting the lead, tin, or lead-tin alloy and adding aluminum to form a molten mixture, reducing the temperature of the molten mixture to form crusts containing the impurities, separating the molten metal and the crusts, and removing the last traces of aluminum from the molten metal.

4. The method of treating lead, tin, and lead-tin alloys to remove the impurities of copper, arsenic and antimony, which consists in melting the lead, tin, and lead-tin alloy, adding aluminum to form a molten mixture, reducing the temperature of the molten mixture to form crusts containing the impurities, separating the molten metal and the crusts and converting the last traces of aluminum into aluminum chloride and removing the same.

5. The method of treating lead, tin, and lead-tin alloys to remove the impurities of copper, arsenic or antimony, which consists in melting the lead, tin, or lead-tin alloy and adding aluminum to form a molten mixture, reducing the temperature of the molten mixture to cause the alloy of aluminum with the impurities to form in crusts, separating the molten metal and the crusts, and treating the crusts to remove the purified metal held therein.

6. The process of reducing the content of \( \text{Sb} \), Cu or As as they may be present as impurities in alloys containing a predominating portion of \( \text{Pb} \) or \( \text{Sn} \), which comprises ascertaining the amount of such impurity metal or metals to be removed, raising the temperature of the alloy to a point at which aluminum will react there with, mixing the aluminum with a body of such alloy at substantially said temperature in proportion not substantially greater than the theoretical combining power of aluminum with said impurity metals, thereby producing an aluminum-compound or compounds with such impurity metal or metals, cooling the mixture, after such cooling separating the resulting dross from said liquid metal and treating the separated metal from the removal of the residual aluminum therein.

7. The method of treating lead, tin, and lead-tin alloys to remove the impurities of copper, arsenic and antimony, which consists in treating the molten lead or lead-tin alloys with aluminum in amount sufficient to form dross containing the impurities, leaving some aluminum in the molten metal, separating the dross from the molten metal and treating the molten metal with sulphur to remove the aluminum contained therein.

8. The method of treating lead, tin and lead-tin alloys to remove the impurities of copper, arsenic, or antimony, which consists in melting the lead, tin, or lead-tin alloy and adding aluminum thereto, stirring and cooling to form crusts containing the impurities, removing the crusts, and then re-heating, stirring and cooling to cause additional crusts to collect on the surface and removing the crusts to remove the last traces of the impurities.