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[54] EXTRACTION OF MERCURY FROM MERCURY-BEARING MATERIALS

[72] Inventors: **Bernard J. Scheiner**, Sparks; **Roald E. Lindstrom**; **Thomas A. Henrie**, both of Reno, all of Nev.

[73] Assignee: **The United States of America as represented by the Secretary of the Interior**

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[58] **Field of Search** 204/94; 75/101

[56] **References Cited**

UNITED STATES PATENTS

300,951	6/1884	Cassel	204/94
410,228	9/1889	Wiswell	204/94
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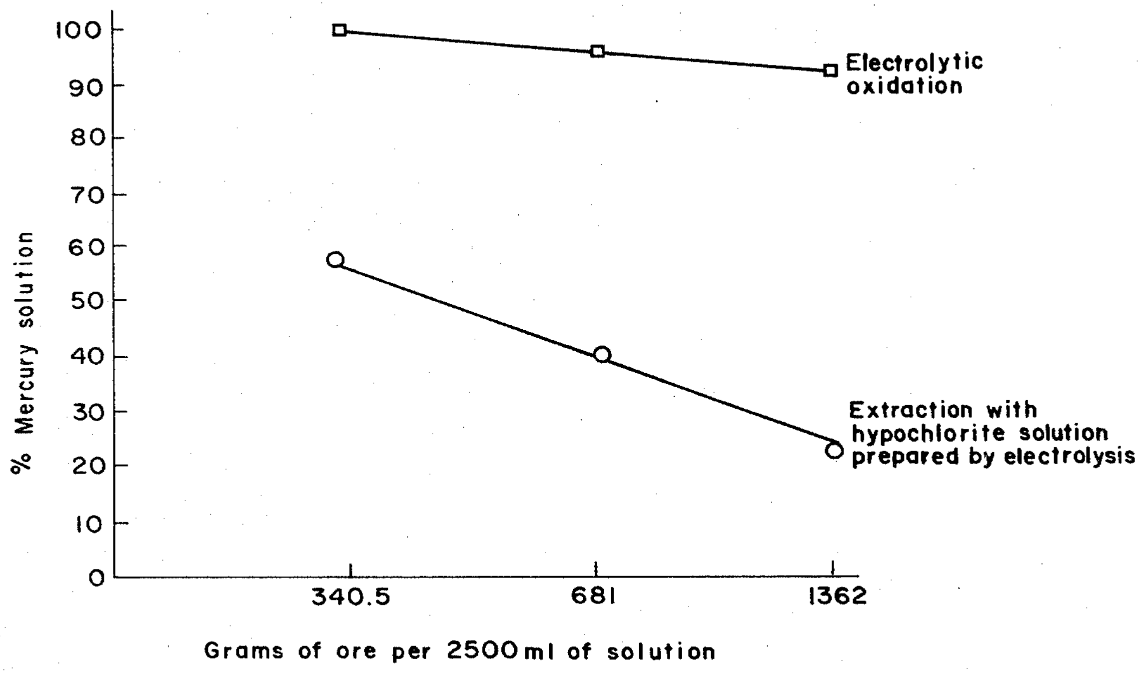
3,476,552	11/1969	Parks et al.	75/101

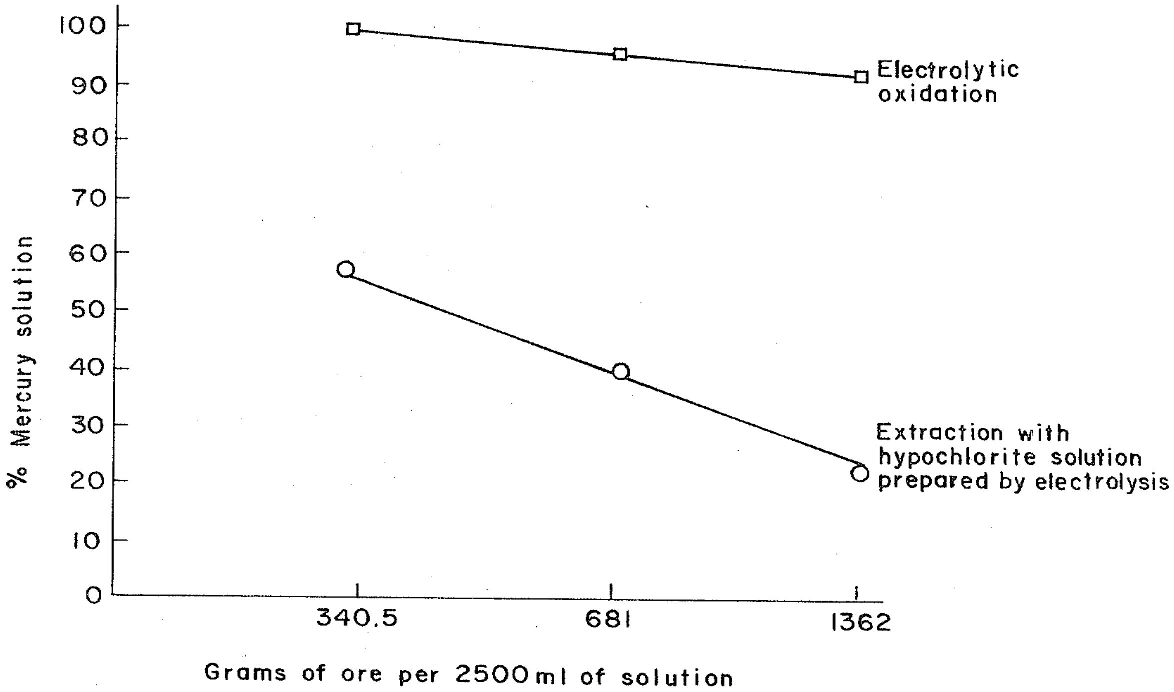
Primary Examiner—F. C. Edmundson
Attorney—Ernest S. Cohen and M. Howard Silverstein

[57] **ABSTRACT**

Mercury is leached from mercury-bearing materials by electrolytic oxidation of the material in a NaCl electrolyte solution.

3 Claims, 1 Drawing Figure





INVENTORS

THOMAS A. HENRIE
BERNARD J. SCHEINER
ROALD E. LINDSTROM

BY Ernest S. Cohen
M Howard Silverstein

ATTORNEYS

EXTRACTION OF MERCURY FROM MERCURY-BEARING MATERIALS

This invention relates to leaching mercury from mercury-bearing materials.

Heretofore, the usual procedure for extracting mercury from mercury sulfide-bearing ores has been to heat the ore to oxidize the cinnabar and volatilize the mercury, followed by condensation of the mercury. This pyrometallurgical process has a number of disadvantages including the fact that there is a relatively low recovery of mercury from low grade ores. Further, the process constitutes a health hazard unless adequate precautions are taken. Although hydrometallurgical processes have been proposed, they have not been of practical importance due to the use of large amounts of expensive solvents.

We have now discovered that over 90 percent of the mercury can be leached from such ores by electrolytic oxidation of the ore material in a NaCl electrolyte solution. This invention is not to be confused with leaching with a hypochlorite oxidizing solution as taught by U.S. Pat. No. 3,476,552. That is, in the present invention, the principal oxidation takes place at the anode during electrolysis. With regard to formation of hypochlorite in the electrolyte during electrolysis, the hypochlorite remains very low in the solution and never exceeds 0.03 to 0.1 weight percent. Further, the chloride concentration is very high during the practice of the present invention which facilitates formation of the stable and highly soluble $HgCl_4^{-2}$ species. Finally, electrolytic oxidation is considerably more rapid than oxidation with a hypochlorite solution.

The process of the present invention is applicable for the removal of mercury from low-, as well as high-grade ores, including minerals such as livingstonite, and from other materials containing it in the form of the oxide, chloride, sulfide or as free mercury. For the purpose of convenience, however, the mercury-bearing material will hereinafter be referred to as an ore.

It is therefore an object of the present invention to leach mercury from mercury-bearing materials.

Another object is to leach mercury from mercury sulfide-bearing ores and concentrates.

A further object is to efficiently leach mercury from low-grade as well as high-grade ores.

A still further object is to employ electrolysis for such leaching.

Other objects and advantages will be obvious from the following more detailed description of the invention in conjunction with the graph drawing in which the present invention is compared with hypochlorite oxidation.

In the practice of the present invention the ore material is passed through a grinding mechanism such as a crusher-ball mill combination. Grinding is, of course, important because it is necessary to release the mineral from the host rock so that it can come in contact with the oxidizing conditions generated at the anode. However, if the ore is ground too fine, the oxidants may be substantially consumed by other minerals in the gangue material. Preferably the ore is ground so that about 80 present of the particles will pass through 35-to 65-mesh standard screen sizes.

Next the ore is slurried in an NaCl salt solution. Preferably, the NaCl is present in the solution in a concentration of about 3 to 10 weight percent. As to the ore-solution ratio, it depends on such factors as the mercury content of the ore. Generally speaking, the ore is present in the pulp in an amount of about 30 to 60 weight present.

Suitable electrodes, such as graphite electrodes, are then immersed in the pulp, and electrolytic oxidation is commenced. Other electrodes are also suitable such as a PbO_2 anode-iron cathode combination, copper cathode-graphite anode, or iron cathode-graphite anode. A PbO_2 -iron combination is particularly effective in that tests have shown that effective oxidation is generated with less than half the salt concentration required for graphite-graphite electrodes.

During electrolysis, pH may range from 1 to 9.5, and operating temperatures are preferably about 25°–50° C. Power consumption generally varies from about 10 to 50 kw.-hr./ton depending on the grade and character of ore being treated.

Electrolytic oxidation time depends on many factors including salt concentration, current density, type of electrodes, electrode spacing, temperatures, particle size, the ore concentration in the pulp, and the treatment rate (amp/ton of ore). Generally speaking, a treatment time of about 1 to 5 hours will be sufficient.

After electrolysis has been terminated, there may be a small percentage of hypochlorite in solution. Under such circumstances, it is desirable to leave the residual ore in contact with the aqueous solution for about 20 to 120 minutes. Thereafter, solid residue is separated from liquid by, for example, filtration, centrifugation or thickeners.

Mercury can then be recovered from solution by, for example, precipitation as the sulfide using sulfide salts, precipitation as metal by cementation using, for example, copper, zinc or aluminum, precipitation as oxide employing, for example, sodium hydroxide to raise the pH, absorption on ion exchange resins, and absorption on activated carbon as taught by U.S. Pat. No. 3,476,552.

The following examples illustrate the effectiveness of the process of the present invention.

EXAMPLE I

1,350 grams of minus 35-mesh ore from the Goldbanks District, Nevada, containing 2.5 pounds Hg per ton, was mixed with 300 grams of NaCl and 2,500 ml. of H_2O in a 4-liter beaker. Graphite electrodes were immersed in the pulp, and electrolysis was commenced. In the preliminary test the following conditions were employed: a treatment rate of 5 amperes; a current density of 0.3 amp/in.^{2}; a pulp density of about 35 weight percent; a salt concentration of 10 percent by weight, and a reaction temperature of 30° C. A group of subsequent tests was conducted thereafter in each one of which one of the above variables was modified accordingly: test group A, salt concentration ranged from 5 percent to 20 percent; group B, temperature was varied from 25° to 50° C.; group C, current density was varied from 0.15 to 1.0 amp/in.^{2}; group D, current load varied from 2.5 to 10 amperes. Throughout all these tests, 90–99 percent of the mercury was extracted from the ore.

EXAMPLE II

These tests were conducted to compare the process of the present invention with leaching a particular ground ore sample (2.4 pounds Hg per ton) with a hypochlorite solution prepared by electrolysis of a NaCl solution. It is well known that hypochlorite solutions can be prepared in this manner, as exemplified by *Industrial Electrochemistry*, C. L. Mantell, McGraw-Hill, New York, 1940, pages 372–375, although comparatively weak solutions are produced thereby. The comparative tests were conducted as follows:

First, a 1,362-gram portion, a 681-gram portion and a 340.5-gram portion, respectively, of the above-mentioned ground ore were each slurried with 2,500 ml. of water containing 300 grams of NaCl. Each pulp was then electrolyzed for 5 hours at 3.2 volts and 5 amperes. After removal of the electrodes, stirring was continued about an hour followed by filtration and analysis for mercury removal.

Next, employing the same electrolytic apparatus, three 2,500 ml. portions of hypochlorite solution were each prepared by electrolyzing 2,500 ml. of water containing 300 grams NaCl for 5 hours at 3.2 volts and 5 amperes. Thereafter, a 1,362-gram portion, a 681-gram portion and a 340.5-gram portion of the above-mentioned ground ore were each slurried in 2,500 ml. of one of the resultant hypochlorite solutions. Leaching was carried out until substantially no hypochlorite was detected in solution; and leaching time was about 16 hours in each case. Filtration and analysis followed.

Throughout all these tests the pH was about 7 during leaching. The test results are shown in the Figure. Referring more particularly to the graph in the figure, it can be seen that electrolyzing a mixture of 340.5 grams of ore in 2,500 ml. of NaCl solution dissolved almost 100 percent of the mercury, while treating the same amount of ore with 2,500 ml. of hypochlorite solution dissolved less than 60 percent of the mercury. When the amount of ore was increased to 681 grams per 2,500 ml. of solution, it can be seen that electrolytic oxidation dissolved about 95 percent of the mercury while the hypochlorite solution dissolved less than 40 percent. At an ore-to-solution ratio of 1,362 grams/2,500 ml., electrolytic oxidation resulted in more than 90 percent mercury dissolution while the hypochlorite solution dissolved about 20 percent of the mercury in the ore.

What is claimed is:

1. A process for extracting mercury from a mercury-bearing material comprising
   a. forming a pulp 30 to 60 weight percent of said material in a NaCl salt solution having a salt concentration of about 3–10 weight percent;
   b. electrolyzing said pulp to dissolve out mercury from said material and form mercury-containing solution and residual particulate solids;
   c. separating said mercury-containing solution from said solids; and
   d. separating mercury from said mercury-containing solution.

2. The process of claim 1 wherein said mercury-bearing material is a mercury sulfide-bearing ore.

3. The process of claim 1 wherein a PbO_2 cathode and iron anode are employed as the electrodes during said electrolysis.

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