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METHOD FOR RECOVERING METALS

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This invention relates to a process and apparatus for the recovery of metals from metal bearing liquids based on their position in the electromotive force series of the elements relative to another metal. More particularly this invention relates to a process and apparatus for recovering copper from copper bearing solutions by the use of sponge iron.

The recovery of a metal from solutions by the cementation process comprises passing metal-bearing aqueous solutions, or pregnant liquors, over a second elemental metal which is above the first metal in the electromotive force series of the elements. In the process the second metal replaces the first metal in solution, and the first metal precipitates onto the surface of the remaining second metal and adheres to it, "blinding" the second metal causing the reaction to slow and finally cease. The process utilizes a surface reaction depending on contact between the pregnant liquor and the second metal for its continuation. However, as the first metal precipitates onto the surface of the second metal the active surface area is reduced; the pregnant liquor is increasingly prevented from contacting the second metal, and eventually the reaction ceases.

In prior art processes, iron is used in the form of shredded sheets to recover copper from solution. After cessation of the reaction the copper coated, shredded iron strips are then customarily removed from the reaction vessel and removed to equipment where the copper is stripped from the surface of the metal. The copper stripping is carried out in a typical process by placing the copper-coated iron into apparatus arranged for rotation and in which the metal is tumbled causing an abrading action that removes the copper from the surface of the iron. The iron and copper are recovered separately and the iron returned to the reaction chamber where it is exposed further to the pregnant liquors.

Because the reaction is a surface reaction, configurations of iron having large surface area per unit weight are especially useful for the reaction. Sponge iron, which is iron having a skeletal structure and very high surface to weight ratio, has been found especially useful in the cementation process recovery of copper. However, the copper coats the surface of the sponge iron in a similar way that it coats the surface of other forms of iron, and the reaction eventually ceases. It is necessary then in the known processes to transfer the copper coated sponge iron from the reaction vessel and remove the copper mechanically. The full speed of reaction of the sponge iron is never realized because of the handling step and also because from the time of initial contact until the time of cessation of the reaction the sponge iron surface becomes continually less available for reaction.

It is an object of this invention to provide a process and apparatus for recovering a first metal from solution by use of a second metal having a relatively higher position in the electromotive force series of the elements which facilitates separation of recovered first metal from unreacted second metal.

It is another object of this invention to provide an improvement to the cementation process for the recovery of copper from pregnant liquors in which cement copper is continuously removed from the surface of a sponge iron precipitant, eliminating the cessation of the reaction and the need for handling and equipment in order to separate recovered copper from unreacted sponge iron.

It is still another object of this invention to provide apparatus for the recovery of copper from pregnant liquors by a cementation process in which copper is continuously removed from the surface of sponge iron.

It is a further object of this invention to provide a process and apparatus for continuously removing copper from pregnant liquors by converting the copper into elemental form and gravimetrically recovering the elemental copper without interruption to the process.

Other objects will be apparent to those skilled in the art from reading the present disclosure taken in conjunction with the drawings, in which :

FIGURE 1 is a cross-sectional elevational view of an embodiment of the apparatus of this invention;

FIGURE 2 is a transverse sectional elevational view of the same embodiment of this invention taken generally along line 2—2 of FIGURE 1; and

FIGURE 3 is a schematic flow diagram illustrating how multiple units of the apparatus of this invention may be used in sequence in the practice of this invention.

The objects of this invention are accomplished by the use of a reaction vessel which increases in horizontal cross-sectional area with increasing height. The vessel may be conical, trough shaped, etc. The vessel desirably has a foraminous conduit mounted inside and near its bottom by which pregnant liquors may be introduced into the vessel. Sponge iron particles are placed over the foraminous conduit in large excess of the stoichiometric quantities required to react with the copper contained in the pregnant liquor to be treated. The vessel has means for removal of spent liquor which may be merely in an open top over which the spent liquor overflows but which preferably is made up of a series of discharge ports in the wall of the vessel near the top of the sides.

One embodiment of the apparatus of this invention is shown in FIGURES 1 and 2 and comprises V-trough shaped vessel **2** having sides **4**, **6** which slant apart in an upwardly direction. The vessel is closed by ends **8**, **10** which are joined to sides **4**, **6**. Mounted inside vessel **2** on bottom **12** is conduit **14** which contains holes **16** which, as shown, comprise three rows in the upward facing segment of conduit **14**. Conduit **14** is connected at one end to a source of copper bearing headwater or pregnant liquor (not shown). The other end of the conduit **14** is closed by cap **18**. Discharge ports **20** in sides **4**, **6** permit the overflow of spent liquor into launders **22**, **24** from which spent liquor containing fine particles of elemental copper is drained through conduits **26**, **28** to a settling cell (not shown). Sponge iron particles **30** are disposed within vessel **2** and tend to settle around conduit **14**. The particles have a high surface area to weight ratio.

In one method of practicing this invention pregnant liquor introduced into vessel **2** through conduit **14**. As the pregnant liquor is discharged through holes **16** in conduit **14**, it contacts sponge iron **30** and levitates the sponge iron particles placing them in turbulent suspension. Sponge iron **30** is maintained in constant agitation by the pregnant liquor. Some of the iron of the sponge iron replaces the copper in the pregnant liquor, and small particles of metallic copper precipitate onto the surfaces of the particles of remaining sponge iron. Because of agitation by the pregnant liquor, particles of sponge iron abrade each other with sufficient force to mechanically remove the metallic copper from the surface of the sponge iron. The particles of elemental copper are smaller than the particles of sponge iron and are carried out of vessel **2** along with the spent liquor from which the copper values have been wholly or partially removed. The spent liquor passes through ports **20** into launders **22**, **24** and through conduits **26**, **28** to settling cells where the small particles of copper settle out of the spent liquor and are recovered.

The particles of sponge iron are larger than the parti-