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Electroplating Solution Management

Abstract

The disposal or treatment of spent metal plating solutions poses significant challenges for the electroplating industry. In general, biotreatment processes may be used for metal-plating solutions to eliminate the dissolved metal content thus allowing for discharge to the environment. In particular, biotreatment using alkane-utilizing bacteria reduces the dissolved metal concentration below allowable discharge thresholds thus allowing for the solution to be discharged as non-toxic waste directly to a municipal wastewater treatment facility.

Background

Electroplating is the process of coating of an object with a thin layer of some metal through electrolytic deposition. The process is widely used for the purpose of rendering a lustrous finish on desirable articles, jewelry, or utensils. The general object of electroplating is to employ the article to be plated as the cathode in an electrolytic bath composed of a solution of the salt of the metal being plated. The other terminal, the anode, may be composed of the same metal or an inert material. A low voltage current is passed through the solution, which electrolyzes and plates the cathodic articles with the metal to a desired thickness.

The most commonly used metal plating solutions include electrolytic and electroless solutions. Electrolytic plating solutions normally contain high concentrations of heavy metals like zinc, chromium, cadmium, nickel, selenium, copper, gold, silver and nickel. Electroless nickel plating solutions, in particular, are also widely used in the plating industry. The solutions contain a nickel metal salt, such as sulfate, acetate, carbonate or chloride salt, pH adjustors, accelerators, stabilizers, buffers, and wetting agents. The electroless nickel solutions only have a limited useful life and eventually becomes depleted or spent.

The spent solutions from the electrolytic and electroless plating processes pose a severe hazard to the environment, if disposed of improperly, and a high monetary cost, if disposed of properly. A number of wastewater treatment processes have been developed to reduce the metal content in spent electroless solutions to low levels prior to discharge. Some methods include the dosing of electroless baths with caustic soda to precipitate the bulk of the heavy metal contaminants as insoluble hydrous oxides (metal hydroxides), pressing the sludge into a filter cake, drumming and disposal.

Another waste treatment used for spent electroless solutions is the dosing of the solution at slightly alkaline pH with reducing agents. The reducing agents typically used to convert the dissolved metal salt into insoluble metal precipitates include sodium borohydride, sodium hydrosulfite and other chemicals.

Another prior waste treatment method known for reducing the dissolved metal content of spent electroless baths to acceptable discharge levels involves organosulfur precipitation of the metal by dosing the spent solution at a pH of 5-8 with water-soluble precipitating agents.

Many current methods involve the removal of dissolved metal from solution by chemical reduction. The spent electroless solution is first contacted with a reducing agent for sufficient time to cause the dissolved metal salt to undergo chemical reduction, resulting in the precipitation of the metal compounds out of the solution. Some methods of electroless nickel solutions rely on reduction followed by precipitation.

Biotreatment of electrolytic or electroless metal solutions using butane in a reduction chamber followed by precipitation chamber provides an efficient and economical process for the waste treatment of metal-bearing solutions. Butane is a non-toxic and low molecular weight organic compound ideally suited to serve as an electron donor under aerobic or anaerobic conditions. Butane-utilizing bacteria in a reduction chamber (anaerobic) may be used to pretreat a metal-bearing solution using metabolic and cometabolic processes. Following treatment in the reduction chamber, the solution then undergoes microbial oxidation in a precipitation chamber (aerobic). Precipitated metals are deposited on a membrane liner (incorporated into pull-out trays) and later recovered.

During a laboratory bench-scale study conducted by GBI, the introduction of butane and air into a spent electroplating solution caused metal precipitation onto a filter paper bed located at the bottom of a bioreactor vessel. Thus the potential exists for using butane to enhance metal recovery from a variety of sources and locations.

References

One or more U.S. Patents Pending.