Short communication

Combined sorption technology of heavy metal regeneration from electroplating rinse waters

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Abstract

A novel process arrangement is presented for treatment of electroplating effluents in order to minimise metal losses and prevent environmental pollution. The method comprises three processes: sorption of heavy metals from the catching bath solution, regeneration of sorbent and electroprecipitation of heavy metals in the electrolyser.

Introduction

In recent years considerable attention has been paid to the problem of improvement of electroplating technology in order to decrease the amount of waste water produced and to develop new methods for its purification. Industrial electroplating appears to be one of the most hazardous among the exisling technological processes. Its toxic effects on all biological objects are due to the presence of heavy metals in the effluents. As only from 30 to 40 percent of all metals used in the electroplating process can be effectively utilised (plated) (Alferova et al., 1990), its waste waters are responsible no) only for supply of pollutants to the environment but also for the greatest portion of metal losses.

As a rule, after the electroplating operation a plated article is washed in a continuous flow; the same water may be used 1 to 3 times. Average water consumption during one rinse operation is about 100 l per 1 m^2 of the plated surface; at the same time approximately 0.2 l of the electrolyte dragged out from plating bath per each 1 m^2 of the article surface is washed off with rinse water (Nevsky et al., 1993). This leads to generation of large volumes of effluent with low concentration of toxic substances significantly complicating waste water purification processes.

Reagent precipitation, sorption of heavy metal ions, electro- and galvano-coagulation and electrochemical extraction are the most frequently employed methods for the treatment of effluents from first-stage rinse baths, or so-called catching baths. Among the common disadvantages of these methods are:

- secondary pollution of purified water by simple inorganic salts;
- intricacy of separation and utilisation of valuable components; and
- massive losses of non-ferrous metals.

Sorption of cations by an ion-exchanger requires its continual regeneration; in this case the expenditure on reagents is 3 to 4 times higher than the stoichiometric value. Reagent precipitation of heavy metals also requires large amounts of costly chemicals. In comparison with the above-mentioned methods electro-coagulation can be considered as the most advanced one, but high consumption of energy and iron or aluminum restricts its wide application. Despite the simplicity of equipment the recently developed ferrite method also has not found extensive application due to high consumption of alkali and ferrous sulphate heptahydrate as well as difficulties in sludge utilisation. The utilisation of sludges for the production of structural and decorative materials is a difficult task because of their variable composition and gradual leaching of heavy metals by natural waters.

Usually exhausted electrolyte and rinse waters are purified separately (Enger, 1992) with pure heavy metals extracted by electrolysis (Grebenyuk et al., 1989). On the other hand the cascade rinsing of articles has recently become widely used in purification of electroplating effluents (Elinek, 1993). During the first stage of this method the solution regeneration is carried out by ion exchange and vacuum evaporation. The distillate is used for the rinsing operation on further stages. Hard toxic sludges formed during this process are deposited at special dumping sites.

The development of closed cycles of water supply for electroplating production (effluent-free technology) should be considered as an ultimate aim when developing new water purification methods. One of the advantages of the closed system of rinse water processing is the lower level of purification imposed, not by a permitted maximum concentration (PMC), but by requirements of the rinsing operation. For example, concentrations of Ni (II), Cr (VI), Zn (II) and Cu (II) ions in waste waters must be lower than PMC which is 0.01 *mg/l*. When the closed cycle technology is used the concentration of these ions is allowed to be as high as 10 to 20 *mg/l* (Golzelmann, 1986). At the same time the volume of treated water decreases substantially.

Among the rinse water purification methods ion-exchange concentration of heavy metals is regarded as one of the most promising (Feksik and Miller, 1993; Shtykov et al., 1991). As far as metal extraction is concerned the regeneration of effluents by electrolysis is considered to be the most effective from an economics and ecology point of view (Langefeld, 1991).

This paper deals with a new technology for rinse water purification combined with utilisation of valuable metals. It results from the investigation into the transport of heavy metal ions across ion-exchange materials with different characteristics. The ions remain in an ion-exchange column when the solution from the catching bath is pumped through it. After the saturation

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