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Recovery of Silver – Review

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ABSTRACT
Since the end of the nineteenth Century, man has learned to use radiation for many beneficial purposes. Today, many sources of radiation, such as x-ray machines, linear accelerators and radionuclide's are used in clinical and research applications. Such beneficial uses may at times create potentially hazardous situations for personnel who work within the hospital. About 27 percent of the silver synthesized every year is used in photographic industry globally. In India lot of Silver Recovery Process Units are extracting silver from X-ray films. Various unique techniques are being implemented. Since silver is an toxic compound, the role of silver is inevitable in certain situations. Precipitation, electrolysis are the major techniques.

Keywords: Silver, Photographic Waste, Silver Recovery Process.

INTRODUCTION

Increasing industrialization and urbanization worldwide had caused serious pollution all around the world, especially in the aquatic environment (J.P.Chen.et.al., 2002).Wastewaters produced by humans are frequently laden with toxic heavy metals such as copper, silver, mercury etc. Silver is one of the basic elements that make up our planet. Silver is rare, but occurs naturally in the environment as a soft, "silver" colored metal. Because silver is an element, there are no man-made sources of silver. People make jewelry, silverware, electronic equipment, and dental fillings with silver in its metallic form. It also occurs in powdery white (silver nitrate and silver chloride) or dark-grey to black compounds (silver sulfide and silver oxide). Silver could be found at hazardous waste sites in the form of these compounds mixed with soil and/or water. The soluble form of these heavy metals is very dangerous because it is easily transported and more readily available to plants and animals (R.Dimeska.et.al. 2006). For humans, poisoning by these metals can result in severe dysfunction of kidney, reproduction system, liver, brain and central nervous systems (V.I..E.Ajiwe.et.al. 2000). Hence, to remove the toxic heavy metals from wastewaters has become increasingly focused. Furthermore, recovery of the precious metals like silver, gold and platinum will not only solve the environmental problems but also have profitable potential.(C.Pillai.et.al.,2008). Silver is a precious metal widely used in the photographic, electrical, electronics, chemical and jewelry industries. Even though it is not as expensive asgold or platinum, silver is still only present in limited amounts in nature, which contributes to the need for efficient methods of recycling silver from waste generated by the above industries.(S.Pavlinic.et.al.,1998).

Photographic Waste

Photographic waste is the waste generated by the photographic processing machine in paper and printing industries. X-ray film also is one of the photographic wastes generated by hospital and biochemical lab. Photographic waste contains silver that is the main material use to transfer image. It contains soluble silver thiosulfate complex and smaller amount of silver sulfite. The light-sensitive properties of silver compounds are the key to most photographic processes, and the basis of most of the waste produced. Like the compounds of many other heavy metals, they are highly toxic, and classified as special wastes. Along with the decreasing amount of silver natural resources, the cost of silver productions has risen rapidly and the price of silver in the market has increased constantly. Every country has focused on the recovery of silver from silver-containing waste (Zhouxiang, 1999).

Silver Recovery-METHODS

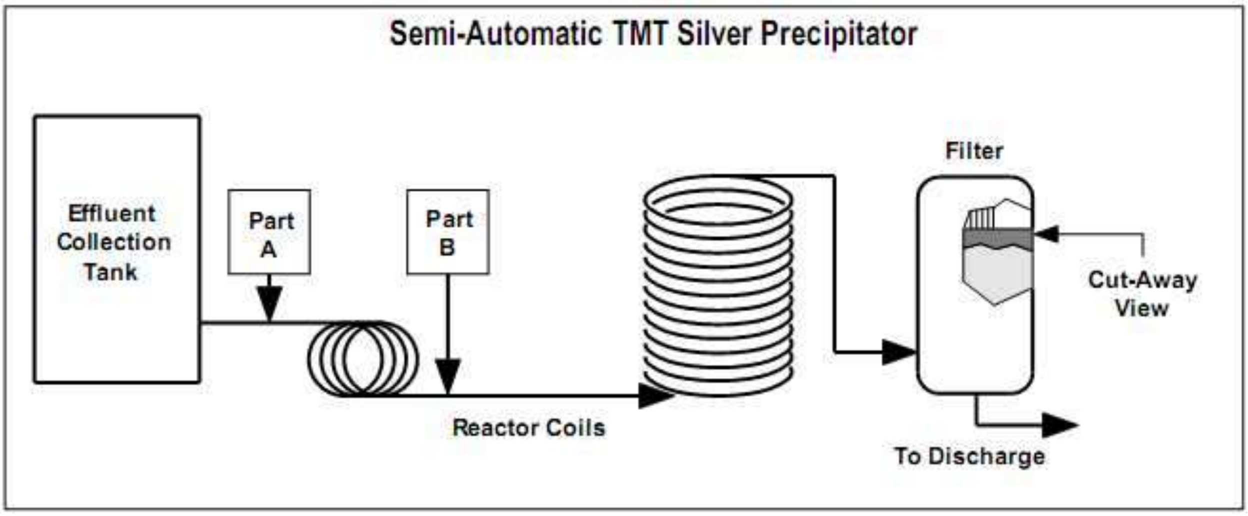
Silver Recovery Process

The silver to be recovered may be present in different forms: as insoluble silver halide, a soluble silver thiosulfate complex, a silver ion, or elemental silver, depending upon the type of process and the stage at which it is recovered (Messerschmidt, 1988). A number of techniques are available to remove silver from silver rich photographic processing solution. Of these, three are used in virtually all practical methods of silver recovery. They are:

i. Precipitation
ii. Metallic Replacement
iii. Electrolysis

Precipitation Process

Precipitation can remove silver from silver-rich solutions, reducing it to very low levels. Properly applied, levels can be reduced to the low ppm range. Until recently, precipitation has not been as widely used as a silver-recovery technique. Common precipitating agents classically have been alkali metal salts of sulfide (sodium sulfide, potassium sulfide, etc) which will form silver sulfide in solution.



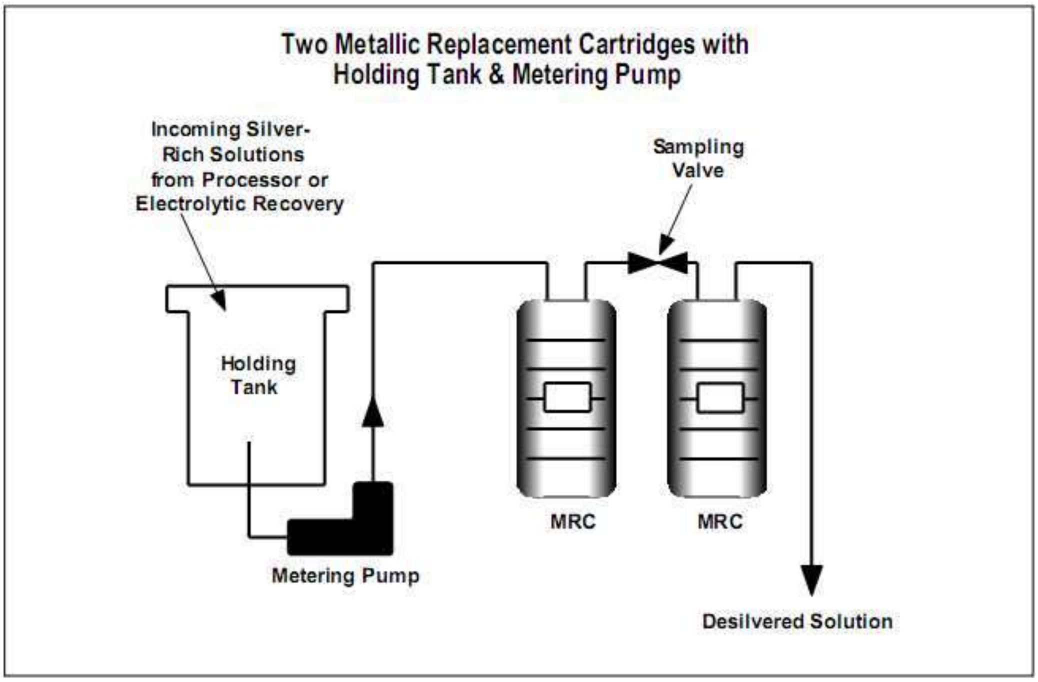
Schematic Diagram for Semi-Automatic TMT Silver Precipitator
Figure-shows a Schematic Diagram for Semi-Automatic TMT Silver Precipitator.

This silver precipitation technique utilized a chemical called TMT (trimercapto-s-triazine) (T. Raju.et.al., 2009). TMT produces an insoluble silver compound that is more easily filtered than silver sulfide. For many processes, silver levels may be reliable and consistently reduces to an average of less than 1.5 ppm. Advantages of TMT include consistent low silver discharge and reduce cost

Metallic Replacement Process

Silver is also recovered from photographic processing solution by replacing the silver with another metal such as zinc by electrolysis or by chemical precipitation with chemicals such as sodium hydroxide or sodium sulphide (Ajiwe and Anyadiegwu, 2000). The basic technique for metallic replacement is the reduction by metallic iron (usually present as “steel wool”) of the silver thiosulfate complex to elemental silver. The commercial equipment commonly used for the recovery is often referred to as Metallic Recovery Cartridges (MRCs) or Chemical Recovery Cartridges (CRCs). The most common source of iron is fine steel wool, chosen for its surface area (Garcia R.M.,1986). The steel wool is wound on a core or chopped up and packed into a cartridge. The silver rich solution are slowly metered into the cartridge and through the iron medium. The silver is left behind in the cartridge while iron is solubilized and carried out by the solution. Like the electrolytic process, metallic replacement is a reduction oxidation process.

The final silver concentration is affected by flow rate, iron surface area, contact time, pH, original silver concentration, thiosulfate concentration, and the volume passing through the cartridge. If the MRC is operating properly, the silver concentration may be reduced to less than 5 mg/



Schematic Diagram for Metallic Replacement Process Using MRCs

Electrolysis Process

Recovery of metals from aqueous solution of their salts by electrolysis can be realized by two methods. The first method consists of the electrolysis of solutions obtained after leaching of the corresponding metal from ores or concentrated with the use of insoluble anodes. The second method consists of the electrolytic refining of the metal (Ajiwe and Anyadiegwu, 2000). In the process of electrolysis, or commonly known as electrolytic silver recovery, a direct current is passed through a silver-rich solution between a positive electrode (the anode) and a negative electrode (the cathode)(D. E. Kimbrough.,1996) During this electrolytic process, an electron is transferred from the cathode to the positively charged silver, converting it to its metallic state, which adheres to the cathode .In a simultaneous reaction at the anode, an electron is taken from some species in solution. In most silver-rich solution, this electron usually comes from sulfite (A.A. Melo.et.al., 2006)

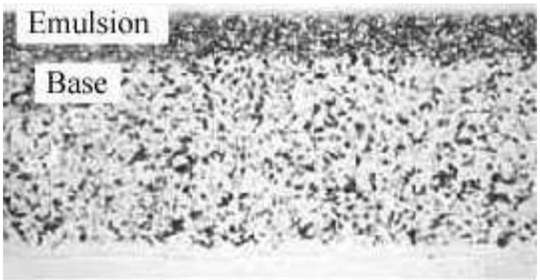
In this work, a filter press-type electrochemical reactor (ER01-FP) was used with a system of three electrodes (working, counter and reference). The capacity of the reactor was 280 mL. A304 SS and Ti (with a geometric area of 64.3 cm2) were used as working electrodes, a saturated calomel electrode (SCE) was used as a reference, and a mesh-type DSA (titanium/ruthenium (IV) oxide) was used as the counter electrode. The solutions used for the analysis in this work included a nitric acid solution of 5%v/v that was free of silver ions and a nitric acid solution of 5%v/v with 250 g of radiographic film (initial concentration of 2100 ppm of Ag+), which are referred to below as the SRF solutions. Both solutions were prepared in the laboratory.

The electrochemical studies were carried out using a potentiostat-galvanostat PAR 263A connected to a KEPCO power source with a capacity of 10 A. The techniques used in the study utilised the software Power Suite®, provided by PAR.

SEM coupled with an EDS Jeol JSM-6300 was used to observe the morphology and the nature of the deposits obtained on the surface of the A304 SS and Ti electrodes. The images were obtained using secondary electrons at 30 kV. Characterization of the deposits obtained on the A304 SS and Ti electrode surfaces

Figure shows an image (200X) of the deposits obtained when imposing currents ranging from -40 to 125 mA on the A304 SS and Ti electrodes. This figure also shows that there is a tendency for a greater amount of deposits to appear on the surface of the A304 SS and Ti electrodes as the current increases. The chronopotentiometric studies with a controlled current produced homogeneous deposits on the surfaces of both electrodes.

Chronopotentiometric Studies



CONCLUSION

Various methods are implemented for the silver removal. Since silver is an toxic compound, the role of silver is inevitable in certain situations. In health care industry for taking X-ray, silver has a pivotal role. So to rocess the silver after usage many techniques are implemented, by electrolysis, precipitation etc

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