Silver recovery from used x-ray film using borax compound

Prof. D.K.Chandre[1]
Dusane Akshay Surendra[2], Vivek Virendra Mishra[3]

[1]Prof., [23]BE Students (Chemical Engineering), S.V.I.T, Chincholi, Nashik, Maharashtra, India.

ABSTRACT

In recent years, enzymatic methods using microbial proteases are being used as alternatives method instead of burning and oxidation methods of silver recovery from X-ray films. But this process is not competitive according to today's advance technologies. Perhaps, recovery of silver by stripping the gelatin-silver layer using chemical reaction is the advanced method to recover the silver from waste. The used X-ray films contain 1.5 - 2 % (w/w) black metallic silver which is recovered and can be reused. Silver recovery from x-ray film is a process in which silver from used x- ray film is recovered in a purity of 99% of silver in order to reuse the silver on the same or the other application and silver is sold back to the market, this is the aim of this project.
Key words: *Silver recovery, X-ray films, gelatin hydrolysis, Borax* ($Na_2B_4O_7.10H_2O$).

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1. INTRODUCTION

Metals play an important part in modern societies and have historically been linked with industrial development and improved living standards. But this also cause serious issue. The improper disposal of industrialization generating metallic waste causes contamination of environment and cause wide adverse effects on human health. These heavy metals are discharged by several industries, such as mining, metallurgical, electronic, electroplating and metal finishing. Therefore the recovery of toxic and or valuable components from industrial wastes becomes necessity for economy aspect and environmental protection. There are a few ways to recover the silver from x-rays, from which we are practicing recovery of silver by stripping the gelatin-silver layer using chemical reaction. This process step removal of gelatin layer, gelatin layer is formation of silver and bromine together on the surface of film at both sides. This layer is about 0.0005 inch thick and removed by NaOH solution forming black solution. Further black solution is filtered and solid sludge is evaporated to form powder. Black powder is mixed with borax compound and heated at high temperature. This process results silver as a product.

X-ray film displays the radiographic image and consists of emulsion of silver halide (AgBr) which when exposed to light, produces silver ion ($Ag+$) and electron. The electrons get attached to the sensitivity specks and attract the silver ion. Subsequently, the silver ions attach and clumps of metallic silver (black) are formed.

2. TYPES OF FILM CONTAINING SILVER

- Medical X-Ray Film

- MRI Film
- CT Scans
- Mammography Film
- Radiographs

Unexposed x-ray film has twice the amount of silver as processing film. If the film gets exposed to light after development, the unreduced silver halides will open gates and be converted to black metallic silver. This is seen as slow blackening of the film. Wastes such as film scraps, spent fixer, spent developer, rinse-water, and spilled chemicals are mainly generated within hospital radiology department premise. Each year, the photography sector allocates approximately 35% of its silver to radiographic applications, which is discarded completely after it is used. Some technologies have attempted to recover the silver contained in these wastes.

3. LITERATURE SURVEY

Nuri Nakiboglu et.al, can conclude a novel, simple, fast, cheap and pollution-free method was developed for recovering the silver from waste X-ray photographic films with NaOH stripping. The method has a number of advantages because it obviates the need for burning, oxidizing, electrolysis or purifying steps. Moreover, all experiments were carried out in the same flask, unlike other techniques. Silver recovery conditions were optimized and silver a purity level of 99% was recovered. The results were compared with results in the literature for high-purity silver using the same method. [1]

Samson O. Masebinuet.al, can highlights the techniques for silver recovery from radiographic waste; effluent and X-ray films. The decline in silver natural resource has increased the cost of sourcing for pure silver. The ecological problem caused by the disposal of radiographic waste is a huge motivation for increased recovery, regeneration and recycling process. The negative impact of pure silver on human and the environment is low but its soluble salt and emission from its recovery process pose a great risk to the ecosystem. Pyro-metallurgical processes of silver recovery requires heat >950°C which also destroys the polymer substrate. Hydrometallurgical processes such as electrolysis, metallic replacement, chemical precipitation and adsorption, are often used and provides high purity and efficiency. A proposed research work for silver recovery based on chemical precipitation using oxalic acid has been presented. [2]

4. EXPERIMENTATION

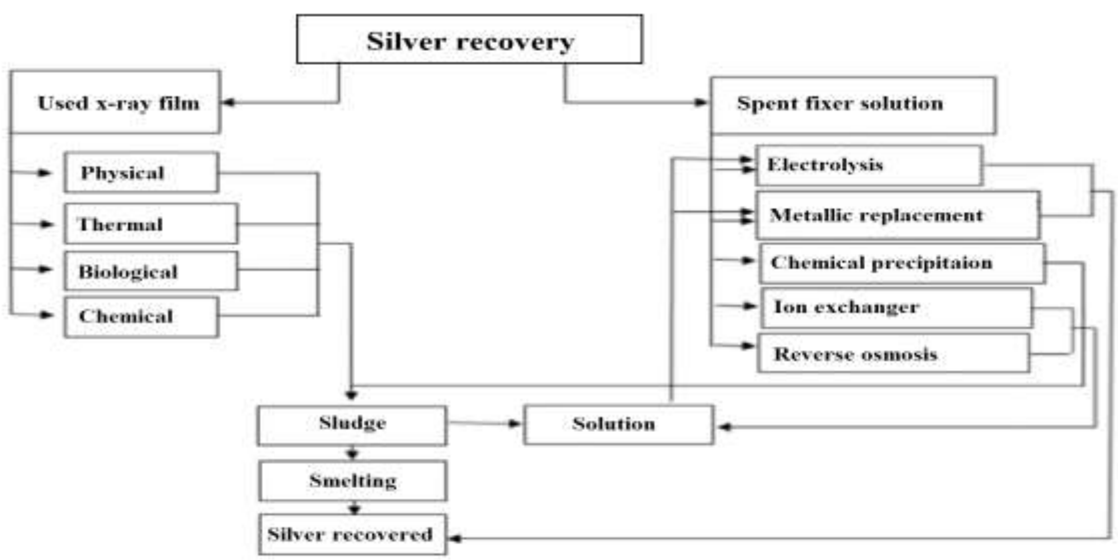

Figure No.1 General Methods for the recovery of silver from photographic waste

In our proposed system the process place in the following steps or phases.

1) First all the used X ray films are collected from hospitals and clinical labs.

2) If the films contents mud, rust, dust or other foreign particles which are stick on the surface of X ray film then this films are wash with water. Due to washing foreign particles are removed, means they does not carry any other reactions.
3) We can apply ethanol on the both side of x ray film; ethanol can be removes gelatin layer easily. If ethanol is not available we can use X ray films directly to the further processing.
4) Ethanol impregnated films then cut into 5*5 cm or according to our need.
5) If the films are wet or the films can contains the moisture, it will create the problems for the processing we needed to do dry the films, if we use wet films it will create the problems in further processing.
6) The cutted films are dried in oven at 40˚C for 30min.
7) We can prepare 0.1 N NaOH solutions by dissolving 40 gms of NaOH pellets in 1 liters of solution.
8) NaOH solution is then heated in heater, when 60˚C to 70˚C temperature is reached we can dip the cutted films in heated solution of NaOH for removing the gelatin layer present in X ray films.
9) When the gelatin layer is removed from X ray films the films colour changes, i.e. dark gray to light sky blue. Then films are removed from the solution. Now cool the hot solution of NaOH.
10) After cooling we observed that the dark gray coloured solids are settling at the bottom of beaker, allow more time (generally 2 hours) to settle the solids in the solution. For improving the settling rate we can add the alum in the solution.
11) After the settling of all the solids in the solution, we can filter the solution which can contain the solids. The filtration is done by filer paper.
12) The solids retains on the filter paper is then removed in the crucible and this solid is dried by the hot air oven or by the use of sunlight.
13) The dried powder of solid is weighted and then taken into the crucible and we can add the equal amounts of sodium thiosulphate and sodium nitrate in it.
14) Mix all the chemicals and dried powder to make the homogeneous mixture.
15) This mixture is then heated in the muffle furnace at 500˚C for 30 minutes, during heating various reactions are occurred
16) After 30 minutes the dish is removed from furnace and allow to cooling, after cooling of powder material we can easily see the silver crystal in burned powder.
17) Big crystal of silver is removed from burned powder and the remaining silver crystals are removed by filtration.
18) For filtration we can take 20 mi of 0.1N sodium thiosuphate solution in small beaker and dissolved the burned powder in it, after some time all the burned material is dissolved in it and silver particles are easily seen.
19) After dissolution we can filter the solution by using the filter paper, silver crystals are retained on the filter paper and this can be easily removed from burnt material

5. REACTIONS

The reaction occurring during the x ray film productions are given below

$$\mathbf{AgBr + X\ Ray\ photon \rightarrow Ag^{+} + Br^{-}}$$

When X ray films are subjected to the heated NaOH solution the products formed are given as follows

$$\mathbf{Ag + NaOH \rightarrow Na+ + AgOH}$$

$$\mathbf{AgBr + 2Na_2S_2O_3 \rightarrow Na_3 + [Ag(S_2O_3)_2] + NaBr}$$

$$\mathbf{2\ Ag + 2OH \rightarrow Ag_2O + H_2O}$$

In first reaction, the silver present in the film was not reacted with pure water but it can remove or helps in removing the silver and gelatin layers. In second reaction, silver crystal is reacted with the sodium hydroxide to form silver hydroxide and sodium crystals (free item). And in third reaction, Ag2O is formed the Ag2O is dark brown solid produce by adding alkali to a soluble Ag, AgOH is probably present in solution but not is in the solid. And in last reaction silver hydroxide is heated to form Ag2O and water molecules.

6. SILVER CONTENT TESTING METHODS

Silver obtained from the process can be tested by using yellow cadmium sulfide that forms brownish-black silver sulfide when it comes into contact with silver. The higher the concentration of silver in solution, the greater amount of brownish black silver sulfide will be formed.

7. MATERIALS REQUIRED

1. Sodium Hydroxide (NaOH) 1N
2. Sodium Thosulphate ($Na_2S_2O_3$)
3. Sodium Nitrate ($NaNO_3$)
4. Waste X ray films
5. Distilled water
6. Ethanol (CH_3OH)
7. Muffle furnace (up to 1200°C)
8. Laboratory heater (temperature range 150°C)
9. Borax powder ($Na_2B_4O_7.10H_2O$)
10. Filtration assembly

8. CONCLUSION

Reuse or recycle of natural mineral resources remains most feasible option to slow down the exhaustion caused to their depletion. By the use recovery process to get maximum benefit like we reduce the solid waste which can be generated by the used X-ray films and we get the precious metal i.e. silver. We can try to find out the chemical composition to get the maximum recovery (nearly to the 90-100%). We will analyses the process to get the best from all and which will be more economical for recovery. We use stripping process for the recovery of silver and it has more advantages than the other processes like less cost of instruments, less manpower and maintenance. From the stripping process of NaOH we can get maximum yield with better purity (silver purity greater than 80%). The stripping process of NaOH is ecofriendly, as it does not create any harmful gases or any harmful compounds/ chemicals, like other processes.

9. REFERENCES

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