Removal of cyanide and heavy metals from gold plating industrial waste water

Joshua Amarnath D[1]*, Rajan S[2], Suresh Kumar S[3]
[1]Professor & Head, Department of Chemical Engineering, Sathyabama University, Chennai-119.
[2]District Environmental Engineer, TNPCB.
[3]Vice President - Environmental Services, SMS Labs.
***Corresponding author: E.Mail: chemicalhod@sathyabamauniversity.ac.in**

ABSTRACT

Cyanide (CN-) is a very toxic compound which forms lethal hydrogen cyanide gas in humid and acidic conditions. It readily binds metals as a strong legend to form variable stability and toxicity. Cyanide that is complexes with copper, nickel and precious metals is amenable to chlorination, but reacts more slowly than free cyanide and therefore requires excess chlorine for efficient cyanide destruction. The stability of cyanide salts and complexes is pH dependent and therefore their potential environmental impacts and interactions can vary. Due to the widespread use of cyanide in electronics, metal plating, ornamental work and utensil production, wastewater containing cyanide has been discharged into the environment increasingly, especially in developing countries (Latkowska and Figa, 2007). Wastewater containing cyanide is treated with two stage treatment with chemical oxidation with metal catalyst. This process is a batch process and removes cyanide and metals with 99.9% efficiency with shorter time due to faster reaction.

Key Words: Cyanide, Environment, Heavy Metals, Pollution, Oxidation.

INTRODUCTION

Many pollutants in the waste water have been identified as harmful and toxic to the environment and human health. The development of a new or improved industrial processes pose an urgent need to develop more effective, innovative and in expensive processes for treatment of inevitable waster. There are three typical plating processes that produce wastes: stripping, cleaning, and plating. Stripping baths contain solutions of acids, including sulfuric and nitric acid. These acids are used to remove dirt and oxide deposits from metal surfaces to ensure proper conditions for plating. Cleaning baths contain organic solvents (for removing oil and grease) and wetting agents. The plating baths contain the solutions of the metal to be plated. These are usually metal salts such as chromic acid, cadmium oxide or copper cyanide. The wastes from these three processes are mainly composed of cyanides, chromates, acids and alkalis. In this application we will focus on the cyanide heavy metals wastes only (Marsden and House, 1992).

Treatment method: Cyanide waste treatment is usually a two-stage process. Stage 1 oxidizes cyanide to cyanate using oxidizing agents such as sodium hypochlorite in the presence of an alkali (pH = 10). This reaction is accomplished most completely and rapidly under alkaline conditions at pH 10 or higher. An oxidation period of 10 to 15 minutes is usually adequate however retention times up to 60 minutes are required to complete the reaction. To avoid producing solid cyanide precipitates, which may resist chlorination, the wastewater should be continuously and vigorously mixed during treatment.

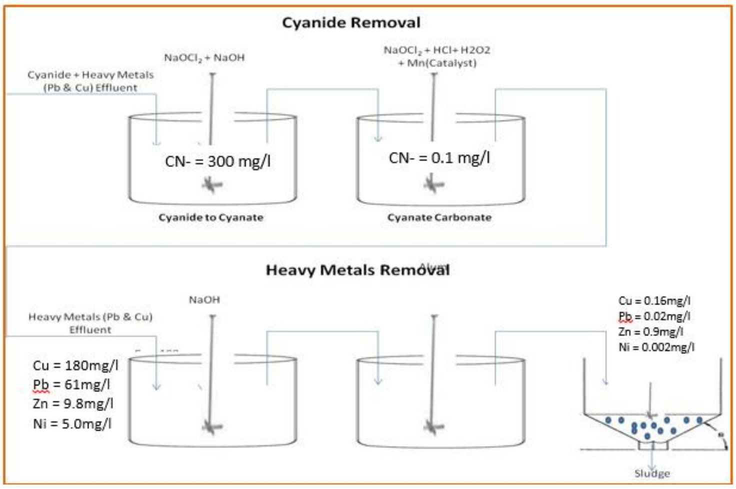

Figure.1.Flow chart cyanide and heavy metals from gold plating industrial waste water

The second stage oxidizes the cyanate (which is much less toxic than cyanide) to carbon dioxide and nitrogen through the use of more sodium hypochlorite in the presence of Hydrogen peroxide with Mn catalyst to enhance the reaction faster, but at a lower pH level than used in the first treatment stage. In this stage, the pH is lowered to approximately 8.5 and additional hypochlorite is added. The retention time of the second stage is typically 120 minutes to complete the reaction but due to oxidation catalyst in the presence of H_2O_2 the retention time will reduce only 10 - 15 minutes with 99.9% cyanide removal.

Ist Stage: The following equation illustrates the chemical breakdown of cyanide to cyanate

$$CN^- + NaOH + NaOCl_2 \longrightarrow NaCNO + 2NaCl + H_2O \quad \text{(pH should bring to 10)}$$

2nd Stage:

$$NaCNO + NaOCl_2 + HCl \xrightarrow{H_2O_2 + Mn} NaCl + CO_2 + N_2 + H_2O \quad \text{(pH should bring to 7.0)}$$

RESULTS AND DISCUSSION

The treatability study results are shown below in Table 1 and Table 2.The analysis was conducted as per American Public Health Association. Standard methods for the Examination of Water and Wastewater.

Table.1.Chemical parameters analysis before and after the treatment

Parameter	Result mg/l	
	Raw Effluent	Treated Effluent
PH	2.5	7.2
Total Dissolved Solid	4481	3860
Cyanide	300	0.12
COD	1051	86

Table.2.Metal Analysis Before and After the Treatment

Element	Raw Effluent water	Treated Effluent Water
Cr	0.057 mg/l	BDL (0.001 mg/l)
Fe	3.03 mg/l	BDL (0.001 mg/l)
Ni	4.47 mg/l	0.002 mg/l
Cu	180.52 mg/l	0.16 mg/l
Zn	9.80 mg/l	0.98 mg/l
Ag	0.14 mg/l	BDL (0.001 mg/l)
Cd	0.03 mg/l	BDL (0.001 mg/l)
Pb	61 mg/l	0.022 mg/l

This treatment technique has been implemented at Common Effluent Treatment Plant at Machulipatinam, Andhra Pradesh, for the Gold plating industries. The capacity of the CETP is 70KLD and made the treatment into batch process. All the reaction tanks are made by FRP with conical bottom with stirrer and dosing system has been installed to make uniform dosing with desired flow rate. The cyanide and heavy metals are almost BDL in the outlet water and the same is passing through ultra-filtration followed by RO. The permeate is reusing again their processes and reject is sprinkled through spray nozzles with high pressure pump in the solar pond.

CONCLUSION

The results of the present investigation show that the process of destruction of cyanide can be achieved in an alkaline chlorination with the controlled pH with chemical oxidation to minimize the treatment time with 99.9% removal of cyanide and heavy metals in the gold plating industries as batch process. The treated effluent is passed through the dual media filter followed by Ultra filtration and RO. The RO reject will further treated by multiple effect evaporation systems. This work was conducted as part of the development of new technology with shorter time to treat the effluent.

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