Recovery of Zinc from Effluent of Plants and Mines

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Abstract—In this paper the recovery of zinc from plants and mines effluent, using the solvent extraction is discussed. Successful usage of solvent extraction as a method to produce zinc in mine industries has been noticeable to recovery this metal from effluent. Solvent extraction of copper from effluent could be used to achieve an acceptable level of environmental apart and avoid contamination of the effluent with undesirable organic compounds. This paper have been investigated the extractors including D2EHPA and TBP. The next step of extraction by extractor is named stripping. In stripping step sulfuric acid and sodium hydroxide are usually used. Use of these materials could raise the recovery of zinc more than 90%. Finally, the result is that zinc in most of solvent extraction methods is produced with recovery more than 90%.

Keywords—D2EHPA, TBP, solvent extraction, strip

I. INTRODUCTION

With sudden increase of hydrometallurgical process solvent extraction has been one of the main processes for the purification, metals separation and their concentration. The availability and use of extractors for this purpose and commercial applications is described in this paper [3].

With success of hydrometallurgical processes in the initial sections, it is natural to examine its application for the secondary section. Flexibility, capital save and benefit in the small-scale factories that can be established and worked economically, demonstrate that this process will succeed. This field has been widely reviewed [2].

The use of solvent extraction in processing of tailings and wastes is in its use in the initial section of Extractive Metallurgy could be different limitations. In fact, differences is in the requirements for the purification of metal combinations that were not found in the initial processing and also scale of operations that will affect on investment costs and human resources. Of course a lot of processes including solvent extraction that for recovery of metals from tailings and waste are designed, still be commercial used in small quantity [3].

Various methods available for the recovery of metals from effluent have been reviewed and discussed in a recent papers. Successful usage of solvent extraction as a way to produce metals in mine industries has been noticeable issue for the recovery of this metals from effluents [2].

Solvent extraction of metals from effluents can be used to achieve an acceptable level of environmental apart and avoid Contamination of the effluents with undesirable organic compounds. Ultimate control of effluent is usually done with lime neutralization. All the organic phase in effluent is reduced By adsorption on produced gypsum. Accordingly, different solvent extraction processes developed or in use for the recovery of metals from effluents [1].

The purpose of the recovery, is purification of solution using solvent extraction of impurities and return the purified material as useable solution into the main process. When the solution again come into the flow is not always necessary that all the impurities are removed. Process must balance the cost with the obtained value from the solution and value of extracted materials. For example, the solutions that belong to this case, is pickling and plating solutions [2].

An evaluation of the written notification of the hydrometallurgical has shown that a large number processes including solvent extraction for recovery of metals from effluent is proposed. Some of these processes are used in the pilot-scale, but very few of this processes are used in commercial operations [3].

II. DISCUSSION

1- Zinc recovery from hydrochloric acid solutions of nugget laundering

Nugget laundering in galvanized industry, usually does with hydrochloric acid. A fresh solution contains 18% hydrochloric acid. Nugget laundering increases amount of iron up to 100-130 g/l. Also the solution will contain 20 to 120 g/l of zinc. Based on the amount of disposal material from galvanized process that has washed, iron and zinc concentrations have been balanced. So that the high concentration of zinc and low concentrations of iron will be together. Used solution, contain one to two percent of free hydrochloric acid [6].

The following processes apply to recover zinc from hydrochloric acid solutions of nugget laundering:

1-1- Metsep process

One way to recover the zinc is Metsep process that is shown in Fig. 1. Zinc from Iron chloride solution separate

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with continuous ion exchange resin. Anionic complex of zinc-chlorine adsorb on the strong ion exchange resin.

In nugget laundering iron produce only in ferrous form. This is the base of a good separation. Before the resin does extraction process, we should wash adsorbed nugget laundering solution on the resin. This action does by returning a portion of washed product which then combines with influent. Resin wash with water and obtain zinc chloride extracted. This solution transforms to sulfate by solvent extraction with D2EHPA and stripping with sulfuric acid. The obtained product is a suitable zinc sulfate solution for electrowinning. Effluent from the ion exchange containing chloride takes thermal decomposition to produce hydrochloric acid iron oxide. Purified Material of Solvent extraction is used to produce hydrochloric acid.

Fig. 1 Metsep process for recovery of zinc from spent solution of nugget laundering

Metsep process was developed by the National Institute of Metallurgy (NIM) in south of Africa and commercially used. Copper sulfate solution had been sold to the electrolytic purifiers [5].

1-2- Mes process

One conversion of Metsep process, is called the Mes process that use for recovery of zinc from nugget laundering solution. The flowsheet for this process is shown in Fig. 2. In this process, we used a solvent extraction circuit for the initial separation of zinc from iron in nugget laundering solution. Zinc in form of zinc chloride complex is extracted with TBP extractor. To prevent the extraction of iron, the iron should be in the ferrous form. Selective extraction of zinc before iron with TBP is less amount than extraction with amine. But this issue is compensated by operational benefits such as additional loading. Zinc is stripped from organic solution with water or diluted sulfuric acid. Strip solution of zinc chloride is combined with initial solution of sulfuric acid in a boiler. So Evaporation of hydrochloric acid and zinc sulfate crystallization take place. Zinc sulfate is cooled with centrifugation of initial solution and then is separated. With setting of the boiler conditions free zinc chloride - sulfate can be produced for electrowining. The combination of hydrochloric acid and distilled water can be used for production of 6 molar hydrochloric acid with more distillation that to can be directly returned to the nugget laundering.

Purified iron chloride can be purified into iron oxide and hydrochloric acid by thermal decomposition or can be used to produce flocculation materials as chemical materials for sewage purification [7].

1-3- Espindesa process

Comparison of Metsep and Mes processes with Espindesa (Zincex) process can be interesting that developed in Spain. This process was developed for recovery of zinc from leach solution result of chloride roasting of pyrite slag. The main composition of this leach solution is similar to nuggett laundering solution. Espindesa process is very similar to the Metsep process. But an initial circuit of solvent extraction is used to separate zinc from iron by amine extractor.

2- Recovery of zinc from rinse water of zinc plating

Recovery of zinc from rinse water of zinc plating is carried out from the alkaline solution of zinc cyanide. Because of cyanide poisoning, rinse water of zinc plating should be purified before disposal and especially its cyanide amount should be reduced to very small amount. Zinc cyanide can be extracted with good recovery from the alkaline solution using the fourth amine.

The flowsheet of this process is shown in Fig. 3.
The process is based on the simultaneous extraction of both zinc and cyanide. Purified solution as a fresh solution is returned to the process. Amine extractor is produced again with stripping by sodium hydroxide; while recovered cyanide and zinc is returned to the plating bath. One sample composition of plating solution containing 40 ppm cyanide and 23 ppm zinc. Solvent extraction decreased this amounts to 0.4 ppm cyanide and 0.07 ppm zinc. Purification with active carbon reduces these amounts to a little more amount and simultaneously remove the amine amount less than 0.1 ppm. One ratio of influent to the strip solution is 1:162 that produces the strip solution with 3-4 g/l zinc.

3- Recovery of zinc (and copper) from mines water

Solvent extraction of copper from mines water can be done with suitable method for production of copper from leach solution of tailings in Arizona or elsewhere in the world [5]. The solvent extraction method is designed for recovery of zinc, but still has not used commercially. A process to recover copper and zinc from mines water was developed based on the H-MHR process. In this process first copper is recovered by solvent extraction using LIX64N extractor. Then iron is selectively deposited with calcium carbonate or sodium hydroxide using air to oxidation. At the end zinc is extracted by second extraction circuit with D2EHPA extractor after passing of filter. This process has been tested at pilot scale.

4- Case Study

In Rayon plant, rinse water and other effluents containing zinc is produced. The total produced effluents of the plant may be several cubic meters per minute. Zinc concentration may also be 0.1-1 grams per liter. Beside zinc effluent contains sulfate and surfactants and pH value of effluent solution is normally between 1.5 to 2. Zinc recovery using Valberg process has been successfully completed. This process is shown in Fig. 4.

Zinc is extracted using D2EHPA in kerosine. At pH value of 2 for the effluent more than 95% zinc can be extracted in two steps. Sulfuric acid is used for stripping. With adjusting of pure flow of stripping solution, zinc concentration in sulfuric acid may increase to an amount of 50 grams per liter or more.

A full scale plant in 1975 with the name of Svenska Rayon was built in Valberg (that located in Sweden). The plant consists of two extraction steps and one stripping step. Recovered Zinc is directly returned to the plant. After extraction of zinc, a final purification of effluent is carried out by lime neutralization before discharge [4].

III. CONCLUSION

1- Various processes exist for recovery of zinc from effluents that is mentioned in this paper a few examples such as Metsep process, Mes process and Espindesa process.

2- In Metsep process before solvent extraction is carried out one ion exchange step. Ion exchange resin is washed with water and is obtained extracted zinc chloride. This solution is converted to sulfate by solvent extraction with D2EHPA and stripping with sulfuric acid.

3- One conversion of Metsep process is Mes process that is used for recovery of zinc from nugget laundering. Zinc as zinc chloride complex is extracted with TBP extractor. Zinc is stripped from organic solution with water or diluted sulfuric acid.

4- Espindesa process applies for recovery of zinc from leach solution result of chloride roasting of pyrite slag. In this process initial circuit of solvent extraction is used to separate zinc from iron by amine extractor.

5- About recovery of zinc from rinse water of zinc plating we should say that Zinc cyanide can be extracted with good recovery from the alkaline solution using the fourth amine. Amine extractor is produced again with stripping by sodium hydroxide.
6- In H-MHR process first copper is recovered by solvent extraction using LIX64N extractor. Then iron is selectively deposited with calcium carbonate or sodium hydroxide using air to oxidation. At the end zinc is extracted by second extraction circuit with D2EHPA extractor after passing of filter.

REFERENCES


