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Review Article

Removal and Recovery of Platinum: An Insight into Studies and Research

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ABSTRACT

In the rapidly growing manufacturing sector, the economizing of the processes is being seen as important area for cost effectively. The heavy metals such as copper, cadmium, nickel etc. needs to be removed from wastewater. The precious metals like gold, platinum, silver etc. are used in electronic industries, mobile and computers. The electronic waste and waste jewelries, catalyst industry waste and catalytic converters contain considerable amount of platinum. The platinum removal and recovery is necessary from ecological and economical point of view. The current review summarizes research and studies on platinum recovery from liquid and solid waste.

Key words: Precious metals, leaching, extraction, recovery, ion exchange, resins.

INTRODUCTION

The removal of various pollutants from wastewater is widely studied area of research. The reason may be the scope for more and more effective methods for removal of various pollutants. The organic matter is one major pollutant which can be treated by various physical, chemical and biological methods. [1-5] The removal of heavy metals can be carried out also by various methods such as adsorption, chemical treatments and various biological treatments. [6-10]

The recovery of heavy metal depends of cost of treatment. The recovery of metals from waste becomes necessity if the metals under considerations are precious metals such as gold, platinum and silver. The ecological and economical considerations make the recovery of these metals, a key area of investigation. Platinum is one such metal used in jewelry, catalyst, chemical and other industries. The current review summarizes research and studies on platinum recovery from waste.

Research and Studies on Removal and Recovery of Platinum

Yahorava and Kotze carried out an investigation on recovery of precious metals. [11] They used ion exchange technology for removal of various precious metals like platinum and gold. They carried out preliminary screening tests for selection of the ion exchange materials. They contacted the solution with resin for different resin-to-solution ratios. The contact time of 24 hours was provided and then the filtration was carried out. They analyzed the solution samples and dried material. They found that in spite of the fact that fibrous ion exchangers are generally more expensive (approximately 25%) than granular ones, they can improve economics of the waste treatment. Harjanto et al. carried out an investigation on leaching of Pt, Pd and Rh from automotive catalyst residue in various chlorides based solutions. [12] Based on chloro-complexes in various concentration of acidic solution, they performed the leaching of platinum-group metals (PGM). By using 3 vol% NaClO, 5 $kmol/m^3$ HCl and addition of 1 vol% H_2O_2, they achieved 88%, 99%, 77% recovery of platinum, palladium and rhodium after 3 h. Mavhungu et.al. carried out investigation on platinum and palladium ions recovery from aqueous solution using grape stalk waste. [13] They studied influence of contact time and pH on uptake. They also applied Langmuir and Freundlich isotherms to the solute uptake. Orthophosphoric acid was used for impregnation of grape stalk. They observed that platinum removal increased with adsorbent dose. The platinum uptake was maximum in acidic pH.

Kononova et.al. investigated the platinum removal for chloride solutions. [14] They used new previously unexplored ion exchangers for the platinum removal. In their investigation they observed that strong and weak basic anion exchangers as well as chelate ion exchangers were able to remove considerable amount of platinum from the solution. Schoeman et.al. carried out an investigation on recovery of platinum and other metal ions from a cyanide heap solution. [15] They used ion exchange resins for the purpose. According to these studies, strong-base anion exchange resins are most effective for platinum removal from effluent. They used two resins namely Minix and Amberlite PWA-5. They observed that in the range 9 to 11, pH had minimum effect on solute uptake.

Umeda et.al. carried out an investigation on recovery of precious metals from acidic wastewater. [16] They carried out investigation on metal recovery by using three methods namely cementation, neutralization and reduction. They observed that addition of deammoniation step increased platinum recovery in the reduction process. It was possible to recover 71 % of the platinum using this method. They observed that under cementation condition, for 0.2 and 0.4 mol/L Fe, Al, Zn powder addition, 6 h contact time, platinum recovery of 20 percent was possible. By using deammoniation and reduction, the recovery of platinum increased to 78.3 percent.

Shams and Goodarzi carried out investigation on platinum recovery from spent alumina supported catalysts. [17] They used pretreated anionic ion exchange resin for the purpose. They used hydrochloric acid for leaching purpose. Nitric acid was used as an oxidizing agent. Sodium hydroxide was used for treating strong basic anionic resins to replace chloride ions by hydroxyl group ions. They passed supernatant of leaching process through a fixed column of hydroxylated strong base anionic resin. An investigation on recovery of platinum from spent naphtha reforming catalyst ($Pt/\gamma\text{-}Al_2O_3$) was carried out by Hasan. [18] They used two methods, first, using aqua regia and the second one using chlorination of spent catalyst. Their investigation showed that chlorination was more efficient method with 93 percent recovery. The recovered platinum after treatment can be used to prepare fresh catalyst.

An investigation on platinum recovery from auto catalytic converters in electro refining process was carried out by Fornalczyk and Saternus. [19] They used copper as a metal collector in pyrometallurgical methods. They used Cu-Pt alloy as anode. According to them, the recovery of the precious metals is necessary from both ecological and economic point of view. Paiva et. al. carried out an investigation on new extractants for separation of platinum-group metals from chloride solutions. [20] They also studied their applications in recycling and recovery. They used N, N'-tetrasubstituted malonamide derivatives for platinum recovery. According to them, these extractants need to be studied further for their use in valuable metal separation. Metal recovery from high level radio waste was carried out in his research by Bush. [21] The separation from radio waste is difficult because of active isotopes of the platinum group metals. Even after complete recovery, the platinum extracted exhibits radioactive properties. According to him it is necessary to wait for decay in radioactivity or to develop unique isotope separation technique.

Lillkung et.al. carried out an investigation on leaching parameters for recovery of platinum metals. [22] They investigated the parameters like the temperature, redox potential and chloride content. According to these studies these parameters increase dissolution rate. Also the effect of these parameters is different for different metals. Green et.al. carried out an investigation on recovery of platinum group metals from UG-2 ores. [23] According to these studies combination of chloride leaching and cyanide leaching can be considered as most efficient method for platinum recovery.

CONCLUSION

Recovery of platinum can be carried out by various ion exchange resins effectively. Also the methods such as cementation, neutralization and reduction were found effective. Fibrous ion exchangers are generally more expensive (approximately 25%) than granular ones but they can improve economics of the waste treatment. Combination of chloride leaching and cyanide leaching is also one of the most efficient methods for platinum recovery. Grape stalk waste was also effective for platinum recovery. In case of radioactive waste, it is necessary to wait for decay in radioactivity or to develop unique isotope separation technique.

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