



Short Communication

Recovery of Metal Value from Electroplating Sludge

*Garole D.J.¹, Garole V.J.² and Dalal D.S.¹

¹Department of Organic Chemistry North Maharashtra University, Jalgaon-425 001, MH, INDIA

²K.E.S. Late S.P. Jain Jr. College Nagothane, Tal Roha, Dist. Raigad 402106, MH, INDIA

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Abstract

A huge amount of metals has been generated in electroplating waste. The metal content in these wastes is sometimes very high and it is, therefore, economically viable to extract and recycle them due to their value as a process credit. Moreover, these wastes are regarded as hazardous because of the leachability of hazardous components. Sulfuric acid is a very effective leaching agent for metal-bearing hydroxide materials. The leaching operation is performed at ambient pressure and without external heating with constant stirring. Leaching time was 30 minutes, followed by solid - liquid separation. The filtrate typically contains better than 99% of the metal values available from the sludge. Selective precipitations for the separation and recovery of soluble metal components common to electroplating sludge's has been developed the separation of Iron & Chromium from the Nickel solution. At ambient temperature (20°C), ferric phosphate will precipitate cleanly in the presence of Chromium and Nickel cations through the pH range 1.5 to 2.0. Further more from solution, chromic phosphate can be made to precipitate through approximately the same pH range by heating the solution to 50 to 60°C. The individual chromium phosphate particles are spherical in shape which results in excellent filterability and minimum surface adsorption of other ionic species. After separation of Iron and Chromium, Nickel was recovered as its salt and recovery was 98.7%.

Keywords: Recovery, nickel, chromium, iron, electroplating sludge, sulfuric acid leaching.

Introduction

Metal bearing hydroxide sludge material is generated by the metal finishing industry. Environmental impact and resource conservation considerations have in recent years promoted development of alternatives to disposing of these hydroxide materials into hazardous waste containment sites. Separation and production of pure metal salts from mixed metal sludge's is one such alternative. In many cases synthesis of these metal salts is very attractive economically, with purified forms demanding high market value. In other instances, metal compounds can be produced for reuse in the metal finishing circuit. Preliminary work on developing a series of selective precipitations for the separation and recovery of soluble metal components common to electroplating sludge's has been completed^{1,2,3}.

Environmental Effects of Metals: Iron: It is a metal in the first transition series. It is the most common element in the whole planet Earth, forming much of Earth's outer and inner core, and it is the fourth most common element in the Earth's crust. Iron plays an important role in biology, forming complexes with molecular oxygen in hemoglobin and myoglobin. Large amounts of ingested iron can cause excessive levels of iron in the blood. High blood levels of free ferrous iron react with peroxides to

produce free radicals, which are highly reactive and can damage DNA, proteins, lipids, and other cellular components. Iron typically damages cells in the heart, liver and elsewhere, which can cause significant adverse effects, including coma, metabolic, adult respiratory distress syndrome, long-term organ damage, and even death^{4,5,6}.

Nickel: Nickel is a metal found in the earth's crust. The average worldwide concentration in soil is 8 parts per million (ppm). About 10% of women and 2% of men in the population are highly sensitive to nickel. A portion of these sensitive people can develop skin rash called nickel dermatitis if they are exposed to nickel through direct contact. This is the most common type of reaction to nickel exposure. Exposure to readily water soluble nickel salts occurs mainly during the electrolytic refining of nickel (producing industries) and in electroplating (using industries). Depending upon the processes used, exposures are usually to hydrated nickel (II) sulfate or nickel chloride in solution⁷.

Chromium: Chromium is naturally found in rocks, animals, plants, soil and in volcanic dust and gases. It is one of the high priority persistent, bio-accumulative and toxic (PBT) chemicals that do not readily break down in the environment,

are not easily metabolized, may accumulate in human or ecological food chains through consumption or uptake and may be hazardous to human health or environment. A PBT chemical, once released to the environment, may present increasing long term toxic effects to human health and the environment, even if the release was of a small amount. Chromium is present in the environment in several different forms. The most common forms are Chromium (0), trivalent (III) and hexavalent (VI). Chromium enters the environment mostly in the Chromium (III) and (VI) forms as a result of natural processes and human activities. It cycles between the soil, the atmosphere, surface and ground waters. Electroplating is one of the several industrial activities^{8,9} Several treatment processes have been suggested removal of heavy metals from aqueous waste streams adsorption, biosorption and recovery of metals from electroplating sludge using coagulation method^{10,11,12}

Material and Methods

Materials: Electroplating hydroxide sludge Ni 6.8%, Cr 5.6 %, Fe 3.2%, moisture 12.0% and remaining was acid insoluble residue the sludge sample was obtained from (M/s Kiran Industries Pvt. Ltd. Ahmadabad, India).

Methods: Sulfuric acid is a very effective leaching agent for metal-bearing hydroxide materials: 10% of sulfuric acid is required for leaching. The leaching operation is performed at ambient pressure and without external heating. The heat of reaction is sufficient to raise the temperature of the leach slurry to about 50°C, which undoubtedly aids the dissolution process leaching time is half an hour, followed by solid - liquid separation. The filtrate typically contains better than 98% of the metal values available from the sludge. A small fraction of un leachable material, usually consisting of acid insoluble comprises the filter cake. The leach solution is usually diluted to yield a total dissolved solids level of 40 g/lit. Filter cake wash water is used in this second dilution to enhance overall metal recovery. The leaching operation produces a feed stream with a pH value of approximately 1.5

Iron Precipitation: An extremely important aspect of this treatment scheme as a whole is the ease of iron removal via precipitation with phosphate. Many hydrometallurgical process streams, and is normally considered to be an Iron is a common constituent deleterious impurity because of its low value. Two precipitation techniques are currently employed industrially to remove iron from process solutions. One technique is the high temperature synthesis of ferric hydroxide which yields a very high surface area solid that is difficult to filter . The second method entails the high temperature formation of a basic hydrous alkali sulfate of iron, a mineral named jarosite. This process requires near boiling solution temperatures for several hours to promote acceptable reaction kinetics, and will reduce the iron concentration in aqueous solution. In spite of these drawbacks, both of these iron removal processes currently

are practiced industrially. A significant, recent development in iron removal technology is the precipitation of ferric phosphate. Ferric phosphate precipitation prevails over the inadequacies of the presently employed industrial techniques. Rapid formation of ferric phosphate occurs in acidic aqueous media at room temperature, requiring an hour or less to reduce several grams per liter of iron. The precipitated solids are spherical, with the lowest specific surface area, and, therefore, the fewer tendencies to adsorb contaminating ions from solution are much reduced.

Chromium Precipitation: Work thus far performed on converting summary of preliminary trivalent chromium is removed from solution by phosphate precipitation in a manner very similar to iron removal. Unlike the solubility of ferric phosphate, however, the solubility of chromium phosphate exhibits a strong dependence on solution temperature, with increasing temperatures promoting reduced solubilities. This property if exploit to achieve a separate ion of Fe from Cr. At ambient temperatures, Ferric phosphate will precipitate cleanly in the presence of chromic cations through the pH range 1.5 to 2.0 from solution, chromic phosphate can be made to precipitate through approximately the same pH range of heating the solution to 50 to 60°C. The individual chromium phosphate particles are spherical in shape which results in excellent filterability and minimum surface adsorption of other ionic species. A market for chromic phosphate exists in the pigment industry.

Nickel Recovery: After separation of Iron and Chromium from the solution resultant filtrate containing nickel was treated with Na₂CO₃ to precipitate nickel as nickel carbonate. The precipitate on addition of sulfuric acid, converted into nickel sulfate, was then separated out as crystals with 95-96 % yield.

Results and Discussion

Investigations of separation and recovery of Iron Chromium and nickel by leaching with Sulfuric acid has been reported here. The method is based on separation and recovery of Iron, Chromium and nickel in sulfuric acid solution at room temperature 50-60 °C; with 10% of sulfuric acid and extraction time of 0.5 hr. The recovery of Iron, Chromium and nickel could be attained about 99.7% and 99.46% and 98.0 % respectively.

Selection of Suitable Leaching acid: The effect of acid on extraction of Iron, Chromium and nickel were carried out with different acids (*viz* HCl, H₂SO₄, HNO₃) to establish maximum extraction conditions of Iron, Chromium and nickel I. From the study, Sulfuric acid was found to be most suitable leaching agent and it gave 99.6 % Iron 99.56% Chromium and 99.7 nickel extraction. The other acids used showed comparatively same extraction of iron, chromium and nickel table-1.

Table No-1
Study of acid concentrations

Acid Concentration	HCl	HNO ₃	H ₂ SO ₄
Weight of Sludge (g)	10	10	10
Extraction time (hr)	0.5	0.5	0.5
Temperature (°C)	20 ⁰ C	20 ⁰ C	20 ⁰ C
% Extraction of Iron	99.6	99.64	99.60
% Extraction of Chromium	99.7	99.60	99.56
% Extraction of nickel	99.8	99.7	99.7
Ph	1.5	1.5	1.5

Table No-2

Study of sulfuric acid concentration

H ₂ SO ₄ Acid (%)	2%	5%	10%
Weight of Sludge (g)	10	10	10
Extraction time (hr)	0.5	0.5	0.5
Temperature (°C)	20 ⁰ C	20 ⁰ C	20 ⁰ C
% Extraction of Iron	32.6	60.6	99.50
% Extraction of Chromium	29.6	58.8	99.56
% Extraction of nickel	30.4	59.7	99.60
pH	1.5	1.5	1.5

Effect of Concentration of sulfuric acid on Extraction of Iron, Chromium and Nickel: The concentrations of sulfuric acid were used in the range of 2, 5 and 10 %, in order to study the effect of its concentration on quantitative extraction of Iron, Chromium and nickel. The results obtained showed that acid percentage were sufficient for the extraction of and Iron, Chromium and nickel table -2.

Conclusion

The present work on recovery of Iron, Chromium and nickel from electroplating hydroxide sludge. Various researchers study on recovery of nickel and separation of Iron and Chromium from sludge. But they were not mention recovery of nickel and separation of Iron, Chromium from sludge Leaching with sulfuric acid concentration, time 0.5hrs. Recovery Nickel 98%, Iron, 98.5% and Chromium 98.3%.

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