

Cyanide Destruction: A New Look at an Age-Old Problem

Cyanide chemistries have been used in mining and industrial process wastewater, including plating operations, since before the start of the Industrial Revolution.

Plating baths derived from cyanide chemistries have been an efficient and economical means of depositing certain metals in commerce. However, issues of toxicity and occupational health have rendered them undesirable, and the search for substitutes has proceeded apace in recent years.

There remain applications for which cyanide chemistries provide the only means of meeting the property and performance specifications required. Consequently, the effective destruction of cyanide wastewater is still an essential issue for the surface finishing industry

Review of Cyanide Destruction Processes

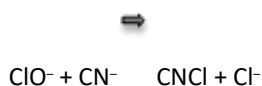
There are several cyanide destruction processes in use today. These include:

- Alkaline chlorination
- Biological treatment
- Caro's acid
- Hydrogen peroxide
- Sulfur dioxide and air

Alkaline Chlorination

The most common form of cyanide destruction for plating processes involves alkaline chlorination. Traditional treatment involves a high pH of 10.5 and a high oxidation-reduction potential (ORP) of +600 mV. It is a chemically heavy process, using approximately 23 gallons of 12.5% sodium hypochlorite solution to destroy one ounce of cyanide. Sodium hypochlorite usage at this rate is quite high.

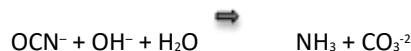
The first step in the process produces cyanogen chloride:



The cyanogen chloride then hydrolyzes to form cyanate:



The second step involves the hydrolysis of cyanate ions to form ammonia and carbonates:



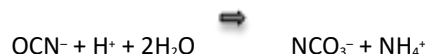
Our new proprietary technology addresses several problems associated with pH and hypochlorite usage. The operating pH is considered reduced at 9.5. Most importantly, advanced technology reduces the equivalent amount of sodium hypochlorite required by 94%, at 1/16 the level of the traditional process.

Biological Treatment

Biologic treatment using bacteria has been used as an effective means of cyanide destruction. Aerobic bacteria, including pseudomonas, alcaligenes, achromobacteria, and others, are used to form cyanates through oxidation:

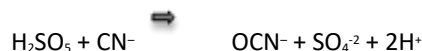


The cyanate ion is biologically converted to ammonia and bicarbonate:



Caro's Acid

Caro's acid, or peroxymonosulfuric acid (H_2SO_5), was introduced in the early 1990s as a cyanide destruction agent. It is produced by an exothermic reaction involving hydrogen peroxide and sulfuric acid. It is very unstable and needs to be used immediately, as the cyanide destruction is a rapid one, reaching completion in just a few minutes:



The oxidation of cyanide to cyanate involves a one-to-one molar ratio in this process. The highly reactive chemistry is a significant disadvantage in using this technology on the scale of plating operations.

Hydrogen Peroxide

The hydrogen peroxide process is widely used at steel hardening facilities, primarily as a case-hardening process for low-carbon steels. Typically, the process involves a molten salt bath of sodium cyanide operating between 1600°F and 1750°F. Again, environmental issues have led to considerably less usage of this technology.

Cyanide destruction by hydrogen peroxide requires a catalyst such as copper to increase the reaction rate. The metals bound by the cyanide must be precipitated as a metal hydroxide. Once again, cyanide is converted to cyanate:

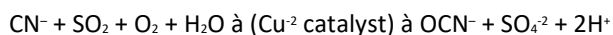


For the bound metals:

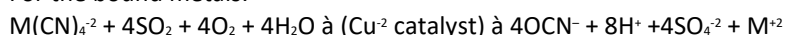


Sulfur Dioxide and Air

Two patented versions of this process, held by Inco and Noranda, are related to nickel processing. In particular, the mining operations use the method to treat tailing slurries. The process effectively treats free and weak-acid dissociable (WAD) cyanides, and a catalyst is required to achieve a practical reaction rate. The reactant from the air is oxygen. Again, cyanide is converted to cyanate:



For the bound metals:



The optimal process pH is in the range of 8-9. The sulfur dioxide can be in the form of liquid sodium dithionite or derived from sodium sulfate or sodium metabisulfite.

Summary

Cyanide chemistry is used in industrial processes while posing environmental and health problems. It is still in use in many mining and industrial arenas, including plating operations, owing to the fact that specific alternatives are few or non-existent. This paper reviews technologies used in the mining and surface finishing industries.

Cyanide destruction is the primary cyanide destruction technology in electroplating and generally involves sodium hypochlorite chemistry. A process is discussed here that allows operation with reduced alkalinity and a significant reduction in sodium hypochlorite usage, reducing the number of safety and chemical consumption concerns.

Our People. Your Problem Solvers.

**For more information on this process,
please call us at 203.756.5521 or email: techservice@hubbardhall.com**

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