Spartan Environmental Technologies
Air and Water Treatment

Technical Bulletin
Cyanide Oxidation

Introduction

Cyanide is used in a number of industrial applications, most notably metal plating. Wastewater from these applications can contain free cyanide which must be destroyed before discharge. In many situations, cyanide levels must be reduced to less than 1 ppm for discharge.

Treatment of cyanide bearing wastewater has been carried out with ozone, hydrogen peroxide, alkaline chlorination (either with chlorine, hypochlorite or on-site generation of hypochlorite using electrochemical systems), and high pressure thermal oxidation.

Advantages of Ozone Oxidation

- Extremely effective against all free and complexed cyanides either alone or in combination with UV light
- Does not form any undesirable by products such a chlorinated organics or ammonia
- Does not require the purchase, storage or handling of dangerous chemicals on site
- Ozone is produced on site from air
- The reaction with ozone does not require high temperatures or pressures

Oxidation of Cyanide with Ozone

Ozone, with an electrode potential of +1.24 V in alkaline solutions, is one of the most powerful oxidizing agents known. Cyanide oxidation with ozone is a two-step reaction similar to alkaline chlorination. Cyanide is oxidized to cyanate, with ozone reduced to oxygen per the following equation:

$$CN^- + O_3 \rightarrow CNO^- + O_2$$

Then cyanate is hydrolyzed, in the presence of excess ozone, to bicarbonate and nitrogen and oxidized per the following reaction:

$$2\ CNO^- + 3O_3 + H_2O \rightarrow 2\ HCO_3^- + N_2 + 3O_2$$

The reaction time for complete cyanide oxidation is rapid in a reactor system with 10 to 30 minute retention times being typical. The second-stage reaction is much slower than the first-stage reaction. The reaction is typically carried out in the pH range of 10-12 where the reaction rate is relatively constant. Temperature does not influence the reaction rate significantly. To complete the first reaction requires 1.8 – 2.0 lbs of ozone per lb of CN-.

Spartan Environmental Technologies, LLC
Phone : 800-492-1252, Fax : 440-368-3569, e-mail : info@SpartanWaterTreatment.com
Web : www.SpartanWaterTreatment.com

Technical Bulletin
Cyanide Oxidation

The metal cyanide complexes of cadmium, copper, nickel, zinc and silver are readily destroyed with ozone. The presence of copper and nickel provide a significant catalytic effect in the stage one reaction but can reduce the rate of the stage two reaction (oxidation of cyanate). Iron, gold and cobalt complexes are very stable and are only partially oxidized, unless a suitable catalyst is added. Ultraviolet light (UV oxidation), in combination with ozone, can provide complete oxidation of these complexes.

UV light causes metal complexes such as ferricyanide and ferrocyanide to partially dissociate. In the case of iron cyanide the compound is photolyzed to free cyanide and iron hydroxide. Ozone then continues the oxidation as noted above.

UV oxidation, in combination with ozone, can completely oxidize all metal cyanide complexes. UV oxidation is limited to relatively clear solutions, since waste streams are passed through a light-transmitting chamber and exposed to intense UV light. UV in combination with ozone results in the formation of OH· radicals, which are strong oxidizing agents capable of oxidizing iron cyanide complexes. Suitable light sources emit in the range of 200 to 280 nanometers (nm). Ozone will absorb in this band. A major advantage UV/ozone oxidation is that no undesirable byproducts (e.g., ammonia) are generated. The following equations summarize the reaction ozone in the presence of UV light:

$O_3 + || h\nu \rightarrow O_2 + O$
$O + H_2O \rightarrow 2OH\bullet$

Spartan Environmental Technologies

Spartan provides ozone based systems for water treatment, including ozone generators and advanced oxidation processes. Spartan can supply a complete ozone cyanide oxidation system including UV reactors as well as on-site electrochemical systems. For information on Spartan water treatment solutions:

Call: 800-492-1252
E-mail: info@spartanwatertreatment.com
Web: www.SpartanWaterTreatment.com