CAIROX®
Potassium Permanganate
CAS No. 7722-64-7

TREATMENT OF CYANIDE WASTES WITH PERMANGANATE

Industrial wastes containing cyanides (produced as a result of the plating or cleaning of metal parts, case hardening, and ore flotation or metal extraction) are often considered more hazardous than other types of industrial wastes. CAIROX® potassium permanganate can be used to cost effectively treat and eliminate toxic cyanide wastes.

### CYANIDE OXIDATION BY PERMANGANATE

**Reactions:**

<table>
<thead>
<tr>
<th>Sodium cyanide</th>
<th>NaCN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potassium cyanide</td>
<td>KCN</td>
</tr>
<tr>
<td>Sodium tetracyanocadmiate</td>
<td>Na\textsubscript{2}[Cd(CN)\textsubscript{4}]</td>
</tr>
<tr>
<td>Potassium tetracyanozincate</td>
<td>K\textsubscript{2}[Zn(CN)\textsubscript{4}]</td>
</tr>
</tbody>
</table>

The above cyanides are oxidized by CAIROX® potassium permanganate to cyanate (CNO).

**Example:**

\[
3\text{KCN} + 2\text{KMnO}_4 + \text{H}_2\text{O} \rightarrow 3\text{KCNO} + 2\text{KOH} + 2\text{MnO}_2 
\]

The above oxidation is achieved in about ten minutes.

If necessary, the cyanate can be further converted to carbon dioxide and ammonium sulfate through acid hydrolysis:

\[
2\text{KCNO} + 2\text{H}_2\text{SO}_4 + 2\text{H}_2\text{O} \rightarrow \text{K}_2\text{SO}_4 + 2\text{CO}_2 + (\text{NH}_4)_2\text{SO}_4 
\]

Certain cyanides, such as silver and iron complexes, are not oxidized by permanganate.

### Cyanide Destruction Process

The procedure for using CAIROX® potassium permanganate to oxidize cyanide to cyanate includes:

A. Raise the pH to 12.4 with lime.

B. Mix rapidly.

C. Add 2-4 mg/L copper sulfate to increase reaction rate (if necessary).

D. Feed a CAIROX® solution to obtain a 30-minute pink end point. Start with a ratio of 4:1 KMnO\textsubscript{4} to CN\textsuperscript{-}.

E. Confirm the absence of cyanide analytically.

If regulations require further destruction of the cyanate, the cyanate can be converted to carbon dioxide and ammonium sulfate, by adjusting to pH 2.5 for 20 minutes. Confirm the absence of cyanate analytically.

### On Line Cyanide Treatment

A metal plater handles sodium and sodium zinc cyanide compounds. As the plated parts are taken out of the cyanide bath, they are submerged for ten seconds in a caustic-permanganate bath prior to the final rinsings. The bath, which contains 12 ounces per gallon of caustic and enough permanganate to produce a deep purple color, effectively removes cyanide below the level of detection.

The plater did not consider the use of bleach or chlorine to treat the cyanide because in certain situations, cyanogen chloride vapor can be created. Cyanogen chloride is 16 times more toxic than sodium cyanide.

### Cyanide Wastewater Treatment

An electroplater needs to reduce 5-8 ppm cyanide in a 1,000 gallon per hour waste stream to less than 1 ppm. The raw water is at pH 9.6. Jar tests determined the cyanide concentration could be reduced to the discharge limit in just ten minutes by using CAIROX® potassium permanganate. Over 92% cyanide removal was observed.

The electroplater feeds CAIROX® until a slight pink color (excess KMnO\textsubscript{4}) is detected. This color change is used as an indicator of reaction completion. Analytical tests are performed to confirm complete cyanide destruction.
Usage Guidelines

For each ppm of potassium cyanide, 1.62 ppm of CAIROX® potassium permanganate are required. The table to the right provides an estimated CAIROX® demand for various potassium cyanide concentrations. This table does not take into account any other oxidizable contaminants that may be present in the wastewater. Laboratory jar tests and field testing are recommended to determine the CAIROX® requirement for a given application.

Carus Value Added

LABORATORY SUPPORT
Carus Chemical Company has technical assistance available to its potential and current customers to answer questions or perform laboratory testing. Carus has complete laboratory testing capabilities including:

* Feasibility Studies  * Toxicity Evaluations  * Treatability Studies  * Analytical Services

FIELD SERVICES
As an integral part of our sales support, Carus provides extensive technical assistance to potential and current customers. When necessary, Carus will conduct laboratory evaluations which duplicate, as closely as possible, the intended use. These evaluations can be useful in determining dosing requirements and equipment needs.

EQUIPMENT SERVICES
Standard Feeders are designed specifically for potassium permanganate. Various options and accessories are available to meet a wide range of applications and customer needs.

Custom-Engineered Feed Systems are complete, pre-engineered and pre-packaged systems, which provide efficient, dust-free methods of storing, mixing, and feeding CAIROX® potassium permanganate. System designs are customized to meet specific applications.

CARUS CHEMICAL COMPANY
During its 90-year history, Carus' ongoing reliance on research and development, as well as its emphasis on technical support and customer service, have enabled the company to become the world leader in permanganate, manganese, oxidation, and catalyst technologies.

Applicable Systems

- Metal Plating
- Case Hardening
- Electronic Manufacturing
- Refineries
- Chemical Processing
- Mining (Ore Flotation / Metal Extraction)
- Centralized Waste Treaters

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