PRINTED CIRCUIT BOARD
APPLICATIONS OF PERMANGANATE

CAIROX® potassium permanganate and LIQUOX® sodium permanganate are well known to the printed circuit board industry for effective desmearing and etchback of through-holes in multilayer boards. Permanganate is also used in the industry to treat chelated, cyanide containing, and high chemical oxygen demand (COD) wastewaters.

DESMEAR AND ETCHBACK WITH PERMANGANATE

Smear
Plated through-holes make the electrical connections between layers of a multilayer printed board. When holes are drilled, friction-melted resin (epoxy), known as smear, coats the surface of the conductive inner layers and should be removed in order to provide a good electrical connection after metal plating.

Desmearing
The process of removing the friction-melted resin is known as desmearing (resin removal up to 0.2 mils thick). The permanganate smear removal process typically consists of three steps; board preconditioning (often contains n-methyl pyrolidone), desmear (potassium or sodium permanganate), and neutralization (often contains sulfuric acid).

Etchback
To help prevent problems with voids or hole wall pullaway, aggressive etchback of the hole wall (resin removal greater than 0.2 mils) can enhance copper plating adhesion to the hole wall. The process is similar to desmearing, except a concentrated sodium permanganate solution is typically used to achieve etchback (enhanced microroughness) of the hole wall.

Permanganate Desmearing Benefits
- Only potassium and sodium permanganate provide excellent microroughness to the hole wall for the subsequent copper plating steps.
  - Reduces incidents of voiding
  - Reduces incidents of hole wall pullaway
- Easier process to control and maintain compared to sulfuric acid and chromic acid techniques.
- Unlike sulfuric acid, results do not vary widely with small changes in dwell time or bath temperature.
- Unlike the plasma desmearing batch processes, permanganate processes result in high production throughput.
- Far less capital intensive than plasma desmearing.
- Less environmental impact when compared to chromic acid disposal issues.

Typical Permanganate Desmearing Bath
Permanganate Concentration (K or Na): 80 g/l
Sodium Hydroxide Concentration: 45 g/l
Temperature: 175 °F
Dwell Time: 10 Minutes

Sodium Permanganate Etchback Benefits
- More aggressive, provides the best microroughness over a wide range of laminates, including FR4, FR5, BT, and other non-PTFE laminates.
  - Reduces voiding and hole wall pullaway
- More convenient to use and maintain than potassium permanganate (sodium permanganate remains in solution even at room temperature).

Typical Sodium Permanganate Etchback Bath
Sodium Permanganate Concentration: 20% v/v
Sodium Hydroxide Concentration: 60 g/l
Temperature: 175 °F
Dwell Time: 15 Minutes

Electrolytic Regeneration of Permanganate
Electrolytic regeneration systems convert sodium or potassium manganate back to permanganate. The benefits of regeneration are as follows:
- Increased bath life. The square feet of boards processed before bath replacement can be increased 3-5 times.
  - Lowers chemical costs by a factor of 3-5
  - Reduces labor
- MnO₂ by-product volume can be reduced 3-5 times.
CAIROX® potassium permanganate is a strong oxidizing agent that can be used to destroy inorganic and organic water pollutants, including sulfur compounds, cyanide compounds, chelated metals, and reduce COD.

### Printed Circuit Board Wastewater Application Points of CAIROX®

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### Aqueous Sulfides

Aqueous sulfides, mercaptans, and reduced sulfur compounds are readily oxidized by permanganate to improve process water quality and remove wastewater odors.

### COD, BOD, and TOC Oxidations

Often the specific organic compounds in the wastewater are unknown and grouped into the general categories of chemical oxygen demand (COD), biochemical oxygen demand (BOD), and total organic carbon (TOC). Permanganate has been shown to contribute to lowering COD and BOD when it is used as a pre-treatment prior to biological treatment systems. On-site tests are recommended to determine whether the compounds present are oxidized by permanganate.

### Cyanide Solutions

Cyanide is oxidized by permanganate to cyanate under alkaline conditions. Permanganate treatment is often applied because its color can be used as an indicator of a completed reaction.

### Chelated Metals

The removal of chelated heavy metals from wastewater is often a challenge. Organic chelating agents (or complexing agents), such as ethylenediaminetetraacetic acid (EDTA), interfere with the chemical precipitation of heavy metals. Permanganate can be used to oxidize organic chelating agents that may “bind” heavy metals. By breaking the chelation, the metals can then be precipitated.

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