

# PLATING PRODUCTS IND PVT LTD

Plot No.G 527, Phase 2, UPSIDC, M.G. Road, Industrial Area, Tehsil Dhaulana, Dist. Hapur, Uttarpradesh 201015.

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Gala No. 116, Saraf Udyog Bhavan, Chincholi Phatak, Malad (West), Mumbai – 400 064.

Phone: 9821340134/ 8104437477 Email: [lab@platingproducts.in](mailto:lab@platingproducts.in) or [info@platingproducts.in](mailto:info@platingproducts.in)

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## Technical Data Sheet P-Brite 23-11

### A Unique Leveling Bright Cyanide Copper Plating Process

#### FEATURES AND BENEFITS

The **P-Brite 23-11** is an extremely versatile, single brightener additive process that can be operated over a wide range of concentrations under a variety of operating conditions. It is easy to use because of its stability.

The brightener does not decompose and is relatively unaffected by the presence of organic and metallic contaminants that affect other brightener systems. Breakdown products are not formed and therefore the bath works very well with evaporative recovery systems.

The **23-11** has excellent throwing and covering power and produces uniformly brilliant deposits on the same part over a wide current range of from less than 1 amp to 120 amps per square foot. It plates brighter over a wider current density range than any other cyanide copper process.

**P-Brite 23-11** is a real money saver in nickel plating processes because of its bright and level underlying copper plate, which reduces the amount of nickel plate required. This is true with steel and with zinc diecastings. It is a high speed bath that plates quickly, uniformly and economically.

The **P-Brite 23-11** process retards the formation of carbonates and hence they do not have to be treated as frequently as with other baths.

The **23-11** process can be used in both barrel and rack lines. It can be cathode rod or air-agitated. Using air agitation allows higher current density and hence higher plating speeds, resulting in greater thickness in less time.

Because it contains no chelating agents, no costly special treatment is needed for copper removal in waste treatment.

**P-Brite 23-11** complies with specifications **MIL-C-14550B** and **SAE-AMS-2418H** for copper plating.

#### OPERATING CONDITIONS

Consistent results are readily obtained from the **P-Brite 23-11** process if the proper chemical balance is maintained. Analysis must be made at regular intervals and the solution adjusted to optimum for copper metal and free cyanide concentrations.

The **23-11** process operates over a wide range of brightener concentrations with the greatest leveling being obtained below the brilliant range.

The **23-11** process is unique in that it gives leveling without current manipulation (pulsing) at temperatures as low as 140°F. Although the bright range is workable at a temperature of 135°F, for better leveling and plating at high current densities, the temperature should be 140°F or higher. The maximum temperature is 180°F.

If, by chance, the **23-11** bath receives an overdose of brightener the plate will only become dull. There will be no roughness or loss of adhesion or ductility; the excess will plate out.

The maximum current density obtainable with the **23-11** process is determined by bath composition, operating temperature and rate of agitation. A bath (Potassium) with 5.5 oz/gal. of metal and a free cyanide of 2.0 oz/gal. operating at a temperature of 160°F will give a bright current density range of from less than 1 to 100 ASF with cathode agitation of 20 ft/min. The same solution, with air agitation, will give a current density range exceeding 120 ASF.

Higher metal concentrations, higher temperatures and high rates of agitation produce a bright finish at high current densities. Because the **23-11** process plates brighter at higher current densities than all other cyanide processes, the current can be turned up, versus other processes, to plate faster in the low current density - - reducing plating time to meet specifications for minimum thickness in low current areas.

## **SOLUTION COMPOSITION**

There are Potassium and Sodium based copper plating baths. A Potassium bath increases the conductivity and the plating speed and promotes cathode efficiency. Potassium baths have better throwing power than Sodium baths and Potassium Cyanide allows for higher current densities.

The composition of plating solution used in the **23-11** process can be varied over a wide range to suit the desired plating condition. The bath formulation may be varied so the metal content is 2.5 oz/gal. for barrel plating. It may be raised above 5.5 oz/gal. for high speed plating (a mil in 10 minutes). Many factors other than bath composition influence electrodeposition; high rates of agitation, shape of parts to be processed, temperature, filtration, tank configuration, racks, etc. Specific problems can be dealt with by our laboratory.

## **POTASSIUM BATH MAKE-UP FOR PLATING ON STEEL**

	Copper Cyanide .....	7.75 oz/gal.
	Potassium Cyanide .....	14.0 oz/gal.
*	Potassium Hydroxide .....	2.0 oz/gal.
	Soda Ash (Sodium Carbonate).....	4.0 oz/gal.

New baths must be carbon treated and dummy plated prior to adding the following addition agents:

<b>Electrosolv</b> .....	5% by volume
<b>P-Brite 23-11R</b> Brightener. ....	1% by volume
<b>P-Wet 300-W</b> Wetting Agent .....	0.1% by volume

## **OPERATING PARAMETERS**

	<b><u>Optimum</u></b>	<b><u>Range</u></b>
Copper Metal	5.5 oz/gal.	2.5 to 8.0 oz/gal.
Free Potassium Cyanide	2.0 oz/gal.	1.0 to 3.0 oz/gal.
Copper Metal/Free Cyanide Ratio	2.5:1	2.0 to 3.0:1
* Potassium Hydroxide	2.0 oz/gal.	1.0 to 2.5 oz/gal.
Carbonates	4.0 oz/gal.	4.0 to 12.0 oz/gal.
<b>Electrosolv</b>	5.0% by volume	3 to 8% by volume
pH	not monitored, but over 10.5	
* For diecast zinc and zincated surfaces the Potassium Hydroxide should be kept at 0.5 oz/gal. or lower.		

Strike baths are normally run at a lower copper concentration and higher cyanide concentration which reduces the efficiency but improves the throwing power and grain refinement while improving adhesion.

## **POTASSIUM STRIKE BATH MAKE-UP FOR STEEL**

Copper Cyanide .....	2.8 oz/gal.
Potassium Cyanide .....	6.2 oz/gal.
Soda Ash. ....	3.0 oz/gal.
* Potassium Hydroxide .....	1.0 oz/gal.

New baths must be carbon treated and dummy plated prior to adding the following addition agents:

<b>Electrosolv</b> .....	3.0% by volume
<b>P-Brite 23-11R</b> Brightener. ....	0.5% by volume
<b>P-Wet 300-W</b> Wetting Agent .....	0.1% by volume

### **OPERATING PARAMETERS**

	<b><u>Optimum</u></b>	<b><u>Range</u></b>
Copper Metal	2.0 oz./gal.	1.5 - 3.0 oz/gal.
Free Cyanide	2.0 oz/gal.	1.5 - 2.5 oz/gal.
Copper Metal/Free Cyanide Ratio	1:1	1 to 2:1
* Potassium Hydroxide	1.0 oz/gal.	1.0 to 2.0 oz/gal.
Carbonates	3.0 oz/gal.	3.0 to 12.0 oz/gal.
<b>Electrosolv</b>	3% by volume	2 - 5% by volume

\* For diecast zinc and zincated surfaces the Potassium Hydroxide should be kept at 0.5 oz/gal. or lower.

Potassium baths plate with a much greater efficiency and wider bright range than Sodium baths. The Sodium bath does offer the advantage of ease of carbonate removal by freezing out at a temperature of less than 40°F for two hours.

A sodium bath will require a considerably higher copper concentration (8 oz/gal.) than an all Potassium (5.5 oz/gal. copper) bath to plate at the same speed.

## **SODIUM BATH MAKE-UP TO PLATE ON STEEL**

Copper Cyanide .....	11.27 oz/gal.
Sodium Cyanide.....	14.4 oz/gal.
* Sodium Hydroxide.....	2.0 oz/gal.
Soda Ash. ....	4.0 oz/gal.

New baths must be carbon treated and dummy plated prior to adding the following addition agents:

<b>Electrosolv</b> .....	5.0% by volume
<b>P-Brite 23-11R</b> Brightener. ....	1.0% by volume
<b>P-Wet 300-W</b> Wetting Agent .....	0.1% by volume

**Note:** Potassium baths are operated at 140°F to 180°F with 155°F being optimum.

### **OPERATING PARAMETERS SODIUM PLATE BATH**

	<b><u>Optimum</u></b>	<b><u>Range</u></b>
Copper Metal	8.0 oz/gal.	6 to 10 oz/gal.
Free Cyanide	2.0 oz/gal.	1.5 to 3.0 oz/gal.
Copper Metal/Free Cyanide Ratio	4:1	3.5 to 4.5:1
* Sodium Hydroxide	2.0 oz/gal.	1.5 to 2.5 oz/gal.
Carbonates	3.0 oz/gal.	3.0 - 12.0 oz/gal.
<b>Electrosolv</b>	5% by volume	3 - 8% by volume
Temperature	175°F	

\* For diecast zinc and zincated surfaces the Sodium Hydroxide should be kept at 0.5 oz/gal. or lower.

## **SODIUM STRIKE BATH MAKE-UP FOR STEEL**

	Copper Cyanide .....	2.8 oz/gal.
	Sodium Cyanide.....	5.1 oz/gal.
*	Sodium Hydroxide.....	2.0 oz/gal.
	Soda Ash. ....	3.0 oz/gal.

New baths must be carbon treated and dummy plated prior to adding the following agents:

<b>Electrosolv</b> .....	2.5% by volume
<b>P-Brite 23-11R</b> Brightener. ....	1.0% by volume
<b>P-Wet 300-W</b> Wetting Agent .....	0.1% by volume

### **OPERATING PARAMETERS**

	<b><u>Optimum</u></b>	<b><u>Range</u></b>
Copper Metal	2.0 oz/gal.	2.0 - 3.0 oz/gal.
Free Cyanide	2.0 oz/gal.	1.5 - 3.0 oz/gal.
Copper Metal/Free Cyanide Ratio	1:1	1.0 - 2.0:1
* Sodium Hydroxide	2.0 oz/gal.	1.0 - 2.5 oz/gal.
Carbonates	3.0 oz/gal.	3.0 - 12.0 oz/gal.
<b>Electrosolv</b>	2.5% by volume	2 - 5% by volume
Temperature	155°F	140 - 160°F

\* For diecast zinc and zincated surfaces the Sodium Hydroxide should be kept at 0.5 oz/gal. or lower.

A mixed bath of Potassium and Sodium will exhibit some desirable attributes of an all Potassium bath while facilitating the freezing out of the carbonates. Mixed baths for the same metal concentration do not give as high a current density range as with Potassium. This can be compensated for by increasing the copper concentration, increasing the rate of agitation and increasing the temperature.

## **SODIUM/POTASSIUM (60/40) HIGH SPEED BATH MAKE-UP FOR STEEL**

	Copper Cyanide .....	13.36 oz/gal.
	Sodium Cyanide.....	12.4 oz/gal.
	Potassium Cyanide .....	7.44 oz/gal.
*	Sodium Hydroxide.....	2.0 oz/gal.
	Sodium Carbonate. ....	2.4 oz/gal.
	Potassium Carbonate.....	1.6 oz/gal.

New baths must be carbon treated and dummy plated prior to adding the following agents:

<b>Electrosolv</b> .....	5.0% by volume
<b>P-Brite 23-11R</b> Brightener. ....	1.0% by volume
<b>P-Wet 300-W</b> Wetting Agent .....	0.1% by volume

### **OPERATING PARAMETERS**

	<b><u>Optimum</u></b>	<b><u>Range</u></b>
Copper Metal	9.5 oz/gal.	8.0 - 10.5 oz/gal.
Free Cyanide	3.0 oz/gal.	2.5 - 3.5 oz/gal.
Copper Metal/Free Cyanide	3.2:1	2.5 - 4:1
* Sodium Hydroxide	2.0 oz/gal.	1.5 to 3.0 oz/gal.
Carbonates	4.0 oz/gal.	4.0 - 12.0 oz/gal.
<b>Electrosolv</b>	5% by volume	3 - 8% by volume
Temperature	175°F	150 - 180°F

\* For diecast zinc and zincated surfaces the Sodium Hydroxide should be kept at 0.5 oz/gal. or lower.

## **FUNCTION OF THE ADDITION AGENTS**

**P-Brite 23-11R** is the makeup and replenishment brightener. Normally the quantity required in a new bath is one percent by volume to produce maximum brilliance and leveling in the plated coating. The exact amount needed is determined by Hull Cell tests of the plating solution.

**P-Brite 23-11R** as a replenisher is added to maintain the luster and leveling of the deposit. The amount required may be determined by observation of the work or by Hull Cell tests. Usually, one quart per 100 gallons will restore the desired characteristic of the deposit. If one gallon per 100 has been added without producing the desired results, other constituents of the solution should be checked for imbalance. **E-Brite 23-11R** is consumed at a rate of one (1) gallon per 10,000 amp hours.

**Electrosolv** is an exclusive anode addition agent and grain refiner. **Electrosolv** produces exceptional anode corrosion and smoothness of the deposit with increased anode efficiency. It also retards carbonate formation which allows for the use of higher current densities and hence much greater plating speed.

**Electrosolv** lets you plate much more economically because the copper in the solution is replenished from the anode rather than with frequent additions of expensive copper cyanide. The amount of **Electrosolv** required in a new solution is 5% by volume. Smaller amounts are helpful when other anode addition agents are present during conversions. **Electrosolv** is consumed only by dragout.

**P-Wet 300-W** is the wetting agent. It is non-foaming and does not cause lack of adhesion. The initial amount of **300-W** required is 1 gallon per 1000. It reduces the viscosity of the solutions which reduces drag out and hence waste treatment. It also assists in producing a clear bright plate. Low wetter concentrations can result in streaking with racked parts.

**SP ( Special Purifier)** is a very helpful addition agent which is used to eliminate the effects of chromium, selenium, sulfur, zinc and some forms of organic contamination. These contaminants usually show up in the Hull Cell panels as bands of varying widths near the mid-range of the panel. Usually, one gallon to 3 gallons per 1000 will eliminate the band if it is caused by the above. An excess of **SP** is not harmful. Additions may be required for several days after conversion. **SP** is not a chelating agent and will not prevent the removal of chromium by treatment with Sodium Hydrosulphite. The sulfur remaining after Sodium Hydrosulphite is easily removed with **SP**.

If a bright shiny copper surface is the desired final finish, then it is recommended that the surface be preserved by the application of **PPI's BPA** passivating agent prior to lacquering.

## **AGITATION**

Cathode rod agitation is acceptable if the rate is greater than 15 ft/min. Air agitation is preferred where high speeds are required. Solution pumping is satisfactory if the solution turnover is high. Sometimes a combination of cathode rod agitation and solution pumping is used. Higher rates of agitation, other factors being equal, permits higher current densities. Air agitation permits the use of higher current densities and is an aid in the promotion of bright, fine grained deposits. Air must be supplied from a low pressure blower equipped with an air intake filter to prevent solid contaminants from entering the plating bath. Compressed air, even with a filter, must not be used as it will introduce oil into the solution and will cause blistering.

## **ANODES**

Oxygen-free UNS C10100 or C10200 only. Use bar or balls. Oxygen-free UNS C10100 or C10200 copper anodes from Univertical, IMC-MetalsAmerica or Outokumpu are acceptable. Do not use phosphorous containing anodes.

## **BAGGING OF ANODES**

Because of the high anode current densities possible with the **23-11** process, anode bags limit the amount of solution circulating around the anode and cause polarization. Bags which permit good circulation are not tight enough to retain small anode particles. With the proper oxygen free anodes, good filtration and chemical control and use of **Electrosolv**, bagging of the anodes is not required for general work.

**Anode to cathode ratio:** 2:1

**Anode baskets:** Titanium

**Voltage:** Up to 12 volts for barrels, rack as required to obtain 20 to 40 ASF.

**Tank:** Rubber lined steel or rigid polypropylene

**Heating elements:** Titanium or Teflon

**Ventilation:** See MSDS's for cyanide and caustic make up chemicals for bath.

## **CONTAMINATION**

Metallic and organic contamination are readily controlled in the **23-11** process. The most common causes of contamination in cyanide copper solutions are from the following:

**Chromium** - Chromium is one of the more common metallic contaminants. Its presence in the solution, in small amounts, causes blistering and also dull, streaky deposits particularly where zinc is also present. Chromium contamination may be controlled by the addition of **SP (Special Purifier)**. Chromium contamination may be removed with Sodium Hydrosulphite without interference by other constituents of **23-11**. Use only 2-3 grams of Sodium Hydrosulphite per 100 gallons of solution. The sulfur remaining after the Sodium Hydrosulphite treatment can be removed with **SP**.

**Selenium** - Selenium, present in some brighteners, in certain valences causes clouds and roughness. In converted solutions treatment consists of the addition of 1 to 2 quarts of **SP** per 1000 gallons.

**Sulfur** - Sulfur is also one of the more common contaminants. It is introduced into the solution usually by relatively impure Copper Cyanide and Sodium or Potassium Cyanide. It may be present as SCN or as organic sulfur. It is removed by treatment with **SP**. Usually, 1 to 2 quarts per 1000 gallons is sufficient.

**Zinc** - Zinc is particularly bothersome in cyanide copper solutions especially in the presence of Chromium or Sulfur. It causes banding and rough deposits. It may be removed by dummieing at low current density. Treatment consists of the addition of **SP**. One or two quarts per 1000 gallons.

**Organic** - Organic contamination may come from a multitude of sources, including airborne dust, buffing compound and impure hydroxides. A small carbon pack is permissible to help control the situation. The best remedy is to improve cleaning and general housekeeping. **SP** in the usual amounts is helpful. Extreme contamination should be removed by carbon treatments.

**Carbon Treatment** - Carbon treatment is required when the deposit lacks an overall brightness, and shows an extremely heavy burn in the high current density area of the Hull Cell test panel. Batch carbon treatment of the entire bath at once is the most effective using 6 pounds of activated carbon per 100 gallons. The carbon containing solution is pumped back into the working tank through a filter. Carbon packs or filter cartridges may also be used if they are changed frequently.

**Filtration** - The rate of filtration required in an installation depends on many factors. Average application of copper, up to 2 mils of thickness, where cleanliness and proper chemical control is

used, requires solution turnover of 2 to 3 times per hour. Deposits of 20 to 30 mils require higher rates.

**Filtering Materials** - There is a wide variety of filtering media offered for use in cyanide copper filtration. Not all are desirable. Asbestos types, clays and some cellulose materials are not recommended. Traces of sulfite in some carbons are not a problem as they can be removed by treatment with **SP**. Some filter media break down in the caustic cyanide solution causing roughness in the plate.

## **ROUGHNESS**

The causes of roughness in cyanide copper plating can be grouped into various classifications:

**Chemical Imbalance of the Solution** - This is a common cause of roughness, particularly in smaller installations where frequent, periodic solution analysis is not performed. Many operators depend on their observation of the anode condition (sludging) for their additions of cyanide and caustic. Once anode sludging has taken place, the addition of corrective amounts of cyanide or caustic will cause the sludge to loosen and enter the plating area to cause roughness. Remedy: Frequent, periodic solution analysis and additions.

**Brightener Imbalance** - This type of roughness may be produced where the solution is not operated according to recommendations. It is particularly a problem with conventional processes where two or more additives have to be maintained, not only in proportion, but in proper concentration. The single additive **P-Brite 23-11** process eliminates such problems. Other processes particularly susceptible to roughness are those containing certain selenium compounds and heavy metals. Some types of selenium, like sulfur when uncontrolled, will cause roughness. This type of problem is also eliminated with the **23-11** process.

**Physical Contamination** - Buffing compound abrasive, metal particles from rough polished steel or tapped holes, airborne lint, dust, filtering media from improperly prepared filter, silicates, sulfates, phosphates as carryover from cleaners or added tap water, all contribute to physical contamination. Anode sludge, poor copper strike, chemicals trapped in torn rack insulation and precipitated in the plating solution also should be considered as sources of roughness. Remedy: Better housecleaning and processing methods.

**Chemical Contamination** - Roughness may be caused by chemical contamination and particularly by Sulfur, certain valences of Selenium, Zinc and Chromium. Other chemical roughness may be due to entrapment of cleaners in the pores of diecastings and porous steel. Chemical imbalance or contamination in copper strikes may also be a source of roughness. The obvious treatment is to eliminate the source of contamination by improved operating conditions.

**Organic Contamination** - Probably the greatest source of organic contamination in cyanide copper solutions is buffing compound. Copper cyanide solutions are "good cleaners". They loosen the compounds and the compounds disintegrate in the hot alkaline solution to give both particle and organic roughness. Other sources of organic contamination might be, unwashed filter bags, uncured rack coatings, etc.

## **SOLUTION ANALYSIS**

### **METALLIC COPPER**

1. Pipette 1 ml sample of the plating solution into a 250 ml Erlenmeyer flask.
2. Add 25 ml distilled or deionized water.
3. Add 2 to 3 grams Ammonium Persulfate - Let stand for a minimum of 10 minutes. (Swirl a few times.)
4. Add concentrated Ammonium Hydroxide (approx. 5 ml) - solution will be a clear deep blue.

5. Add 50 ml distilled or deionized water.
6. Add 8 drops of PAN INDICATOR.
7. Color should be purple or a pale red.
8. Titrate with EDTA Solution (0.1 Molar) to a yellow-green end point.

**Calculation: oz/gal. of copper metal = (ml of EDTA) x 0.849**

### **FREE CYANIDE**

1. Pipette 5 ml sample of the plating solution into a 250 ml Erlenmeyer flask.
2. Add 50 ml water and 5 ml of a 10% Potassium Iodide Solution.
3. Titrate with standard Silver Nitrate 0.1N until a faint turbidity persists.

**Calculations: oz/gal. of Free (Sodium Cyanide) = ml of 0.1N AgNO<sub>3</sub> x 0.262**

**oz/gal. of Free (Potassium Cyanide) = ml of 0.1N AgNO<sub>3</sub> x 0.348**

### **SODIUM (POTASSIUM) HYDROXIDE**

1. Pipette 5 ml sample of the plating solution into a 250 ml Erlenmeyer flask.
2. Add 10 ml of water and 1 gram Sodium Cyanide.
3. Add 10 drops of LaMotte Sulfo-Orange Indicator solution.
4. Add 1 drop Alkali Blue Indicator.
5. Titrate with 1.0 Normal HCL solution until the orange-brown color changes to apple-green.

**Calculations: Sodium Hydroxide, oz/gal. = ml of HCL (standardized x factor (1.07)**

**Potassium Hydroxide, oz/gal. = ml of HCL (standardized x factor (1.5)**

### **CARBONATES**

1. Pipette a 10 ml sample of the plating solution into a 250 ml beaker and add 100 ml distilled (room temperature) water.
2. Add 25-30 ml of 10% Barium Nitrate while stirring. Allow to settle, test solution in beaker with 2-3 drops of Barium Nitrate to see if additional precipitate forms. If not, filter; if more precipitate forms add 10 ml of Barium Nitrate, stir and again allow to settle. Repeat this step until no additional precipitate forms.
3. Filter, using a # 40 filter paper. Wash with room temperature distilled water.
4. Test filtrate with a few drops of 10% Barium Nitrate to make certain all carbonates have been precipitated.
5. Transfer filter paper and precipitate to the original beaker and add 50 ml of distilled water. Break up paper and precipitate to a slurry with a stirring rod.
6. Add three drops of 0.2% Methyl Orange solution.
7. Titrate while stirring with 1.0N HCL until a permanent pink is obtained.

**Calculation: Sodium carbonate, oz/gal. = ml of HCL (Standardized) x factor (0.706)**

**Potassium carbonate, oz/gal. = ml of HCL (Standardized) x factor (0.919)**

### **ELECTROSLV ANALYSIS**

1. Pipette a 5 ml sample into a 250 ml Erlenmeyer flask. (Under the Hood) add about 10 ml concentrated Hydrochloric Acid and boil until there is no precipitation left and solution is clear yellow, indicating that all cyanide has been removed. (If the volume falls below 5 ml, and



precipitate is still present, start with a new sample and add 20 ml concentrated HCL and boil. **REMOVE FROM HEAT IMMEDIATELY** after the solution is a clear yellow, as in the above procedure.)

2. Dilute the above solution to 50 ml with distilled water and add 1/2 gram of zinc dust. Stir well so as to precipitate all the copper. (This is indicated by the absence of the green or yellow color in the solution.) If the solution is green or yellow add 1/4 gram more zinc dust and allow to effervesce again.
3. After the zinc dust has absorbed the copper and the effervescence has stopped, filter through #41 filter paper into a 250 ml graduated Erlenmeyer flask. (CHECK THE FLASK MARKINGS FOR VOLUME ACCURACY BEFORE USING.) Wash filter paper well with room temperature distilled water, (approximately 150 ml). The filtrate should be colorless. Bring the filtrate volume up to EXACTLY 200 ml with distilled water. MIX SOLUTION WELL.
4. Pipette exactly 50 ml of this solution to 500 ml Erlenmeyer flask.
5. Add 5 ml of concentrated Sulfuric Acid. Then add 1.0 - 2.0 grams of Manganese Sulfate (Monohydrate) and 100 ml distilled water.
6. Heat to about 170°F - 180°F, and add slowly with agitation, EXACTLY 20 ml of standard 0.1 Normal Potassium Permanganate solution. Keep the temperature stable for all samples. **DO NOT BOIL.**
7. Allow the hot solution to stand for at least 5 minutes and then cool to room temperature under running water or ice bath.
8. Add 10 ml of 20% Potassium iodide and titrate with 0.1N Sodium Thiosulfate until a light straw yellow color is noted. Then add approximately 1-2 ml of 1% starch solution. **Make a fresh starch solution daily.** The color of the solution should be dark blue. Continue titration with 0.1N Sodium Thiosulfate until absence of blue color is noted for approximately 1 minute.

**Calculation: % Electrosolv = (20 - ml of 0.1N Sodium Thiosulfate) x 1.36**

### **CAUTION**

**P-Brite 23-11R** as well as the plating solution contains cyanide - toxic. Wear safety glasses or face shield, rubber gloves and apron when handling **P-Brite 23-11R** or its solutions. Avoid breathing mists or vapors. Do not get in eyes, on skin or on clothing. In case of contact flush skin or eyes immediately with plenty of water for at least 15 minutes. For eye contact call a physician immediately.

**Do not mix P-Brite 23-11R** with acids, oxidizers or other materials.

Anyone working with **P-Brite 23-11R** should be very familiar with all safety related information found in the **MATERIAL SAFETY DATA SHEET** furnished by **PPI**. **Electrosolv**, **SP** and **P-Wet 300-W** are all considered non-hazardous but good safety practices should be followed when using these products as well.

### **IMPORTANT NOTICE! For Industrial Use Only**

The following is made in lieu of all warranties, expressed or implied, including the implied warranties of merchantability and fitness for purpose: seller's and manufacturer's only obligation shall be to replace such quantity of the product as proved to be defective. Before using, user shall determine the suitability of the product for its intended use, and user assumes all risk and liability whatsoever in connection therewith. **Neither seller nor manufacturer shall be liable either in tort or in contract for any loss or damage, direct, incidental or consequential, arising out of the use or the inability to use the product.**