



DK-110 PLUS

Bright Nickel Plating Process

INTRODUCTION

The **DK-110 PLUS** bright nickel process is outstanding for producing exceptionally fast rates of leveling and brightening for decorative plating. When operated according to the following instructions, the **DK-110 PLUS** bright nickel process is capable of giving excellent deposits of nickel on different basis metals with maximum rates of brightening and leveling. It is especially designed for air-agitated applications. The brightener system employed is versatile and gives excellent results in Watts baths.

The outstanding features of the **DK-110 PLUS** bright nickel process are:

- ÿ Outstanding bright whitish nickel deposit with superior rates of brightening and leveling without loss of ductility
- ÿ Exceptional low current density bright range, giving the ability to produce clear bright deposits in recesses and on areas of intricate shape
- ÿ Excellent chromium receptivity
- ÿ Ease of control and maintenance under production conditions

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BATH COMPOSITION

Nickel Sulfate (NiSO ₄ 6H ₂ O) -	225 - 375 g/L
Nickel Chloride (NiCl ₂ 6H ₂ O) -	53 - 150 g/L
Boric Acid (H ₃ BO ₃) -	38 - 56 g/L
DK-99 Carrier -	8 - 10 ml/L
DK-110 PLUS Brightener -	0.4 - 0.8 ml/L
DK-88 Wetter -	1 - 2 ml/L

OPERATING CONDITIONS

	<u>Range</u>	<u>Preferred</u>
pH -	3.5 - 5	4
Temperature -	49 - 66° C	60° C
Current Density -	2 - 10 A/dm ²	2 - 8 A/dm ²

MAKE-UP MATERIALS

The choice of plating bath composition depends on the particular operating requirements such as cathode current density, type and finish of the basis metal, thickness of deposit, and shape of the article to be plated. Because of the flexibility of the DK-110 PLUS nickel process, it can be used with a variety of nickel plating bath formulations. The following make-up composition of the Watts type bath is one that will meet many plating requirements.

	<u>1,000 Liters</u>
Nickel Sulfate (NiSO ₄ 6H ₂ O) -	250 kg
Nickel Chloride (NiCl ₂ 6H ₂ O) -	55 kg
Boric Acid (H ₃ BO ₃) -	40 kg
DK-99 Carrier -	8.0 liters
DK-110 PLUS Brightener -	0.5 liters
DK-88 Wetter -	1.0 liter

MAKE-UP PROCEDURE

The solution should be made up in a storage tank that has been thoroughly cleaned. All dirt, grease, etc., should be wiped off and the tank sides and bottom scrubbed with a solution of DK-88 wetting agent and hot water, and then thoroughly rinsed. The lining of the tank, filters, etc., should be leached with 0.2 to 0.5% by volume solution of sulfuric acid heated to 60° C containing 1 liter per thousand liters of DK-88 Wetter. Leaching should continue overnight. After this has been completed:

1. Fill tank about two-thirds full with deionized water, heat to 60 - 71° C.
2. Add and dissolve the required amount of nickel sulfate ($\text{NiSO}_4 \cdot 6\text{H}_2\text{O}$).
3. Add and dissolve the required amount of nickel chloride ($\text{NiCl}_2 \cdot 6\text{H}_2\text{O}$).
4. Add enough nickel carbonate (NiCO_3) to raise the pH to 5.2.
5. Add 2.5 ml/liter of 30% hydrogen peroxide, well diluted with water.
6. Add 2.4 g/liter of activated, powdered carbon and stir for 30 - 60 minutes. Turn off agitation and allow carbon to settle to bottom of the tank for 3-4 hours or, preferably, overnight.
7. Clean filter & repack it with a mixture of diatomaceous earth filter aid & carbon.
8. Filter this solution into the plating tank that has been leached and cleaned in the same manner as the storage tank.
9. Heat solution to operating temperature, add the boric acid and agitate to dissolve.
10. Dilute tank to near final volume and confirm that bath is at operating temperature.
11. Adjust the pH to 3.5 - 4 with a 10% by volume sulfuric acid (Chemical Pure or Analytical Reagent grade).
12. Electrolyze solution with dummy cathodes at 0.5 A/dm² for about 12 hours. Use of agitation and filtration during this period is beneficial.
13. Readjust the pH, if necessary.
14. Add the required amounts of DK-110 PLUS Brightener, DK-99 Carrier and DK-88 Wetter, circulate for 20 minutes to assure thorough mixing, and commence plating.

PROCESS CONTROL

Nickel Sulfate is the main source of nickel ions which deposit out as metallic nickel at the cathode, i.e., on the work being plated.

Nickel Chloride supplies chloride ions to facilitate anode corrosion, increases conductivity and makes it possible to plate at higher current densities.

Boric Acid stabilizes the pH of the cathode film by exerting buffer action.

DK-99 CARRIER has strong ductilizing and stress-reducing abilities and is added to maintain maximum brilliance and ductility of the deposit. It is depleted very slowly by electrolysis and is removed only slightly by continuous filtration through a carbon pack.

DK-110 PLUS Brightener contains the primary brightener for the DK-110 PLUS process. Replenishment of the additives is determined by deposit properties and analysis.

DK-88 Wetter is used in mechanical and air-agitated baths respectively. Normally, little or no anti-pitting agent is required for the prevention of pitting. However, the maintenance of a small concentration of DK-88 (e.g. 0.5 ml/liter) will insure the production of pit-free deposits under most production conditions. Replenishment of DK-88 may be accomplished based on stalagmometer measurements. Both DK-88 are removed by batch treatments with activated carbon. DK-88 tends to saturate a carbon-packed filter, and continuous operation under these conditions results in only a minor loss of this addition agent.

Temperature of the plating solution should be maintained between 50-70° C. The use of automatic temperature control is recommended to assist in maintaining constant operating conditions. Operation at higher temperatures provides benefits such as improved leveling, higher permissible current densities, and greater solution conductivity. However, before selecting a higher temperature, the operator should make certain that the equipment will withstand it. Higher temperatures will require recalculation of addition agent consumption. The use of additives may be greater. The DK-110 PLUS bright nickel process can be operated at lower temperatures (38-50° C) by utilizing higher nickel chloride and boric acid concentrations.

pH of the DK-110 PLUS plating solution should be measured regularly and maintained within the range of 3.5 - 4.5. Dilute C.P. or reagent grade sulfuric acid (one part sulfuric acid added carefully to ten parts of water) should be used to lower the pH. Nickel carbonate, applied to the filter, should be used to raise the solution pH.

Cathode Current Density - Bright deposits are produced by the DK-110 PLUS bright nickel plating process over a wide range of current densities. The operator should take the proper steps to assure proper nickel metal concentration, good racking, proper positioning of parts, adequate agitation, etc., where current density extremes are encountered.

Anode Current Density - As in plating solutions in general, the average anode current density is determined by dividing the total tank current by the anode area. It is desirable that this value not exceed 1 A/dm^2 , although 'S' rounds will operate at higher values. This value may be used as a very rough guide for design purposes. Comparing this figure with the cathode current density range, it is evident that the anode area normally must be many times greater than the area of the work being plated. In practical operations, permissible anode current density is affected by many factors such as type of anode material and anode bag, amount of solution agitation, operating temperature, nickel chloride concentration, and pH. Consequently, attempts to maintain anode current density at a specific numerical value are seldom, if ever, made and such attempts are not likely to give useful results. Good nickel anode operation is based on an easily observed fundamental plating principle. The anode area must be sufficiently large so that the anodes will dissolve and replace the nickel removed by plating. In other words, the total anode area must be large enough so that the anodes do not become 'passive' or 'polarized'.

SOLUTION REPLENISHMENT

The following table of consumption rates of the DK-110 PLUS nickel process addition agents will be found to fit nearly all installations. If the actual rates in the plant are found to be different than the tabulated values, your local A&D representative should be consulted.

<u>Addition Agent</u>	<u>Addition Rate</u>
DK-110 PLUS Brightener	80 - 150 ml/kAh
DK-88 Wetter	10 - 30 ml/kAh
DK-99 Carrier	50 - 100 ml/kAh

EQUIPMENT

Tank or tank liner -	CPVC, PVC, Koroseal-lined steel, or polypropylene
Pumps -	High temp. or conventional plastic suitable for acid applications.
Heaters -	Quartz, PTFE, or Titanium. The titanium should be grounded or anodically biased.
Racks -	Plastisol-coated steel or Plastisol-coated copper. Stainless steel should be avoided.
Filters -	6-8 turnovers per hour through a 5 micron polypropylene cartridge or horizontal plate filter packed with diatomaceous earth filter aid.
Anodes -	1. 'S' rounds or pellets 2. Electrolytic nickel in small, rectangular pieces 3. Rolled 99+% depolarized or carbon-type nickel
Anode Bags -	Dynel, polypropylene, or cotton leached in a 5% by volume sulfuric acid solution and then flushed with hot running water prior to use.
Anode Hooks -	Monel or titanium
Anode Baskets -	Titanium

Steel or iron containing materials should be avoided anywhere around the tank (e.g. ventilation, tank supports, piping, etc.). The acid environment will corrode such materials and drippage may contaminate the plating bath. Equipment fabricated from or soldered with lead or lead-based materials that comes into contact with the plating solution should not be used.

STORAGE

DK-110 PLUS Brightener, DK-99 Carrier and DK-88 Wetter should be stored in a cool, dry location and not near supplies of food, drink or animal feeds. Containers should be kept closed. The shelf life on unopened containers of these products is one year.

GENERAL SAFETY PRECAUTIONS

When working with this product(s), ensure that all health, environmental, and safety regulations and standards are met. Avoid direct contact with this material. Do not inhale associated mist, vapors, and/or dust. Emergency showers and eyewashes must be readily available.