



PRODUCT INFORMATION

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MARTRON ENP PROCESS (FOR ELECTRONIC PROCESS)

Martron ENP Process offers numerous advantages for precision nickel plating in the electronic, printed circuit, and allied fields where low or controlled stress, ductility, and good color are desired. Available either in watts nickel or Sulfamate nickel versions, the process is characterized by simplicity of operation and high tolerance to metallic impurities. Excellent as an underplate for gold.

SOLUTION COMPOSITION and OPERATING CONDITIONS

WATTS NICKEL FORMULATION:

NICKEL SULFATE (NiSO ⁴ 6H ² O)	40 - 50 oz/gal
NICKEL CHLORIDE (NiCl ² 6H ² O)	3 - 6 oz/gal
BORIC ACID	4 - 6 oz/gal
Martron ENP Additive	0.1 - 4.5% by volume
Martron APA-2	0.125 - 0.25% by volume
TEMPERATURE	125° - 145°F
pH RANGE (ELECTROMETRIC)	3.8- 4.2
CURRENT DENSITY RANGE	5 - 100 ASF

SULFAMATE NICKEL FORMULATION:

	OPTIMUM AMOUNTS	
NICKEL SULFAMATE	25 - 45 oz/gal	38
NICKEL METAL AS SULFAMATE	10 - 12 oz/gal	10
NICKEL CHLORIDE	1 - 4 oz/gal	4
BORIC ACID	4 - 6 oz/gal	6
Martron ENP Additive	0.1 - 5% by volume	3% vol
Martron APA-2	0.125 - 0.25% by volume	0.25% vol
TEMPERATURE	125° - 145°F	138°F
pH (ELECTROMETRIC)	3.8- 4.2	4.2
CURRENT DENSITY		

SOLUTION PREPARATION

If a new ENP solution is to be made up, **Martron Inc.** can supply specific instructions that will insure an easy and trouble free start up.

CONTROL

The control of an operating **Martron ENP Process** solution is straight forward.

A. The pH should be checked daily and adjusted to maintain the solution is in the proper range. A pH meter should be used rather than papers.

B. The major bath components should be analyzed using standard wet chemical techniques every 1 – 2 weeks, depending on how heavily the bath is used and how uniform the work load is.

C. The level of the **Martron ENP Process** addition agents can be determined in either of two ways: Empirically by in-plant hull cell or other small scale, plating tests; or analytically by submitting a sample to **Martron Inc.** The suggested method is to use in-plant plating test for routine analysis and to submit a sample to **Martron Inc.** on a monthly basis for complete addition agent analysis.

REPLENISHMENT ADDITIONS

Additions can be made periodically by hand or by means of an amp-hour feeder pump. Generally, the latter method is suggested. It reduces brightener consumption and insures more uniform plating quality. If additions are made by hand, materials should be diluted approximately three to one with water and spread uniformly over the surface of the operating solution. Also, smaller, more frequent additions are preferred over larger, less frequent ones.

Additions of wetting agent should only be made as needed to control pitting, and then in approximately 0.05% vol increments.

A. NICKEL SULFATE/SULFAMATE

Nickel sulfate supplies part of the nickel ions to the operating solution. The remainder are supplied by the nickel chloride. The operating limits suggested previously should be maintained to insure burn free, high quality plating. In dilute concentration baths, utilizing lower concentrations of nickel sulfate, higher concentrations of nickel chloride are required.

A low nickel sulfate level generally means an overall low level of nickel metal, and will reduce cathode efficiency, thus necessitating longer plating times to deposit a given thickness of metal. A high nickel sulfate level allows higher operating current densities, but also requires higher concentrations of addition agent in order to achieve proper plating quality.

B. NICKEL CHLORIDE:

In addition to supplying the balance of the nickel ions to the solution, nickel chloride improved bath conductivity, and anode corrosion, the suggested concentration range should be followed to prevent anode polarization, and any accompanying increase in brightener consumption. A high concentration should be avoided since it will decrease deposit ductility. Additionally, operating at higher nickel chloride concentrations can lead to increased attack on processing equipment.

C. BORIC ACID:

Boric acid acts an overall pH buffer for the solution. Its effect is most noticeable in higher current density areas where it (1) prevents burning and pitting, (2) helps to provide deposit ductility and (3) maintains the proper cathode efficiency.

The proper concentration of boric acid minimizes an increase in bath pH in the region immediately adjacent to the cathode. This, in turn, minimizes the formation of metallic hydroxides from any metallic impurities present in the solution. This is important since these hydroxide compounds would otherwise be included in the deposit, resulting in brittle and/or burned plate.

A low concentration of boric acid can cause the previously mentioned problems. A high concentration is not detrimental to performance, except that it can lead to shelf roughness if it is present in a concentration above its solubility limit.

The solubility of boric acid is dependent upon the concentration of other constituents in the bath, as well as the operating that applies for a wide cross-section of operating installations. Most installations have discovered the easiest way to maintain the proper concentration of boric acid is to handle an anode bag full of boric in the corner of the operating tank, where it does not interfere with production. As the concentration in the operating solution drops, additional material will dissolve, and maintain the concentration just below the saturation point.

In the unlikely event the concentration reaches the point where roughness occurs, the solution should be cooled to approximately 39°C (100°F) and filtered to remove the excess boric acid. Also, additions should be withheld until the concentration drops to the correct level.

D. MARTRON APA-2:

This is a low foaming surfactant which is added as required to control hydrogen gas pitting. It is suitable for either mechanically or air agitation nickel baths. It is not intended to be used as a purifier to hide the effects of a continuing introduction of impurities. Also, it does not exhibit detergency properties and will not emulsify dragged-in oils or greases.

A low concentration can result in pitting, primarily in higher current density areas. A slight to moderately high concentration has no effect, but an extreme excess can result in cloudy deposits.

E. TEMPERATURE:

All nickel baths operate at elevated temperatures. The optimum temperature depends upon a variety of factors described earlier in this literature. In order to minimize the energy cost associated with nickel plating, as low an operating temperature as can be utilized without affecting quality should be employed. In addition to fuel savings, lower operating temperatures reduce addition agent costs since brightener consumption is lower, often by as much as 20%. Also, drag-out costs are less since a more dilute electrolyte is used.

In-plant experimentation is suggested to determine how far the operating temperature and solution concentration can be lowered without causing problems. Too low an operating temperature or to dilute an electrolyte causes high current density burning at normal amperages. Keep in mind that higher chloride concentrations should be used with dilute baths operated at lower temperatures in order to achieve the proper bath conductivity.

F. pH:

The recommended pH range for rack plating solutions and barrel plating solutions is 3.8 – 4.2. A lower pH is suggested for barrel plating to minimize laminated deposits and to insure maximum deposit ductility. This is especially important as barrel plated parts are to be formed or crimped after plating.

Nickel baths operated within the recommended pH range will generally plate with a 92 - 95% cathode efficiency and with a 97-99% anode efficiency. Due to this difference in efficiencies, some hydrogen ions are neutralized as the solution is used in production. Since hydrogen ions are the source of acidity in the bath, as they are neutralized during plating, the pH tends to rise. This necessitates regular additions of acid to an operating solution to maintain the pH within the proper range.

Either sulfuric or hydrochloric acid can be used. Sulfamic acid is preferred and is more commonly used. If hydrochloric is used, technical grade is preferred in order to minimize the introduction of dissolved iron in the solution.

Too high an operating pH in a barrel plating solution increases the possibility of laminated deposits. In rack plating solutions too high a pH can cause deposit roughness. This occurs because metallic impurities tend to precipitate as hydroxides at pH result in brittle deposits and reduced chrome receptivity due to a tendency for organic films to remain on the surface of plated deposits.

A low operating pH increases the solution's tolerance to dissolved metallic impurities, which can be beneficial, but too low a pH reduces leveling and brightness and should be avoided.

The pH of an operating solutions can be increased in either of two ways: (1) acid additions can be withheld and plating continued until it reaches the proper level; or (2) nickel carbonate can be added. Additions of carbonate are difficult to dissolve

and should be made only if absolutely necessary. Also, in these cases, additions must be made via the filter. Failure to do this will result in extremely rough deposits.

Installations that regularly use a large surface area of insoluble auxiliary anodes may require regular additions of carbonate. This is because the use of auxiliaries reduces the neutralizations of hydrogen ions and the pH will tend to drop rather than rise.

The amount of acid (or carbonate) required to maintain the bath in the proper range should be relatively constant, as long as the mix of parts processed doesn't change significantly. If there is a change in the amount of acid (or carbonate) required, it's an indication that anode polarization is occurring. This can be due to low anode area in the bath or to cake or crusted anode bags. In any event, it's an easy trouble shooting technique that should be kept in mind.

G. CATHODE CURRENT DENSITY:

The cathode current density is the total current to the plating tank provided by the total cathode surface area in the tank at a given time. The recommended bath compositions allow plating over a very wide operating current density range without burning. Additionally, the **Martron ENP Process** produces a bright and level plate at all normal current densities. Hence, closed control is not usually required. Too high an operating current density produces burning, while too low a current density results in decreased plating speed.

H. ANODE CURRENT DENSITY:

The anode current density is calculated in the same manner as the cathode current density, except that the current to the tank is divided by the total anode surface area. An easy rule of thumb if titanium baskets are used is that the current should not exceed 25 amps for each 30 cm (12 in.) of basket length filled with anode material. This will keep the maximum anode current density below approximately 3.5 a/sq dm (30 asf), which is near the suggested upper limit.

Too low an anode current density (i.e. too large an anode area for the current drawn) is not especially detrimental, except that the nickel metal concentration can rise during production. Nickel metal concentration can rise during production. However, too high an anode current density (too low an anode area) can cause anode polarization and, if severe, generation of chlorine gas at the anode, which has detrimental effects.

I. ANODE TYPE AND BAGS:

Electrolytic chips, SD (sulfur depolarized) chips, and rolled depolarized, cast or rolled carbon, high purity nickel anode materials are all suitable. Standard titanium anode baskets, using Monel or titanium hooks, are recommended if chips are used.

Electrolytic chips are the preferred anode material. They produce the least amount of insoluble sludge upon dissolution. SD nickel chips slightly reduce the voltage required to achieve a given current. However, SD chips also form insoluble nickel sulfide "fines" that are difficult to contain within the anode bags and which can cause "stardust" type roughness on plated parts if they enter the plating solution. If SD nickel is used, double bagging of the anode baskets is strongly recommended in any case where small amounts of particulate matter in the bath can cause rejections due to shelf roughness.

Napped dynel or napped polypropylene bags are recommended. Bags must always be leached prior to use. Best results are obtained by soaking bags in cold running water for 8 to 10 hours. A less satisfactory alternative is to leach for the same time in hot water containing 0.5% volume sulfuric acid and 0.1% volume of **Martron Air Wetter**. Failure to properly leach bags can introduce sizing agents to the bath which are extremely difficult to remove, and which affect the quality of plating. Micro-pitting, and/or hazy deposits, which are difficult to chrome plate, often occur.

J. FILTRATION:

The filter should be sized to turn the solution over at least once per hour, and should either be constructed of, or lined with, a material suitable for use with nickel plating solutions.

Hoses made of reinforced rubber or plastic are recommended, although rigid PVC or PVDC pipe can also be used. The discharge line from the filter should be plumbed so that solution is returned to the bottom of the plating tank, but not aimed directly at the being plated, the anode baskets or the bottom of the tank. Filter cartridges are sprayed during manufacturing with the same anti-static agents as are used for manufacturing anode bags. Thus, if a cartridge type filter is used, cartridges must be leached using the technique described in section L, pages 8 and 9.

K. TREATMENT TANK

All nickel-plating solutions periodically require batch treatment to remove the impurities that build up as a result of electrolysis, or are dragged into the solution. These treatments should be done in a separate storage or treatment tank, never in the plating tank itself.

The treatment tank should be of a material similar to the plating tank itself. It should be equipped with both agitation and some means of heating the solution since most treatments are more effective if they are carried out at elevated temperatures.

L. SAFE HANDLING

The **Martron ENP Process** addition agents are near neutral liquid that do not require special handling. However, the preparation and maintenance of the solution in which they are used require the handling of acidic materials.

Additionally, since the operating solution contains nickel ions, there is the possibility of "NICKEL ITCH", a form of dermatitis, when working with solutions containing the additives.

The **Martron ENP Process** additives are industrial chemicals and should not be taken internally. Avoid prolonged or repeated contact with the skin. Avoid contact with the eyes. Wear proper protective clothing and safety gear. Wash frequently. In the event of contact, flush affected area immediately with fresh running water. If solution is splashed in the eyes, flush with fresh running water for at least 15 minutes and contact a physician if necessary.

M. STORAGE

The **Martron ENP Process** addition agents do not require any special storage considerations, other than they will freeze and should not be stored in areas subject to extremely low temperatures. If material does freeze, it should be moved to a warm area and allowed to thaw.

N. WASTE TREATMENT

The **Martron ENP Process** addition agents do not require waste treatment, nor do they complicate the waste treatment of solutions in which they are used. Nevertheless, the effluent from operating nickel solutions generally requires treatment prior to discharge. Standard methods of treatment are satisfactory, as are proprietary treatment methods.