enthone

Technical Data Sheet

ENPLATE® NI-425

High phosphorus, electroless nickel process
designed for corrosion protection and high build-up appplications

FEATURES OF THE ENPLATE NI-425 PROCESS

- **Excellent Corrosion Resistance**
- **Compressive Stress**
- **Suitable for High Build-Up Applications (>10 Mils)**
- **Minimal Porosity at Thicknesses of >0.4 Mil**
- **Good Lubricity, Wear and Abrasion Resistance**
- **Narrow Melting Temperature, Suitable for Brazing and Welding**
- **Good Stability, Long Life**
- **Non-Magnetic Deposit**

ENPLATE® NI-425 is an advanced electroless nickel process designed to produce deposits exhibiting superior performance in many engineering and functional applications. The carefully selected solution additives provide good solution stability and a moderate plating rate and produce a deposit with minimal or no porosity on properly prepared surfaces. The **ENPLATE NI-425** process chemically deposits a uniform nickel phosphorus alloy and is capable of plating on a wide variety of substrates including aluminum alloys, stainless steel, carbon and alloy steels, copper alloys, etc., as well as certain non-conductors. READ ENTIRE TECHNICAL DATA SHEET BEFORE USING THIS PRODUCT.

The **ENPLATE NI-425** is recommended where superior corrosion resistance is desired. Uses include components in the electronics industry, oil and gas, printing, aerospace, and chemical processing industries. **ENPLATE NI-425** is particularly useful for food and meat processing applications, and for medical and surgical parts due to its resistance to staining. The high phosphorus content of the deposit adds to its functional properties including a compressive stress with resulting minimal fatigue debit. The narrow melting range of the deposit makes it suitable for certain welding and brazing applications.

ENPLATE NI-425 meets MIL-C-26074 and AMS 2404 specifications. **ENPLATE NI-425** can be supplied as a self pH adjusting ammoniated process or a non-self adjusting pH process (non-ammoniated). In either case, the **ENPLATE NI-425** is supplied as three separate liquid concentrates. For the self pH adjusting or ammoniated version, **ENPLATE NI-425A** and **NI-425B** are used for solution make-up; **ENPLATE NI-425A** and **NI-425D** are used for replenishment. For the non-self pH adjusting or non-ammoniated version, **ENPLATE NI-425A** and **NI-425B** are used for solution make-up; **ENPLATE NI-425A** and **NI-425C** are used for replenishment.

The **ENPLATE NI-425** process is one of several electroless nickel processes designed to meet specific performance needs. Others include: ENPLATE NI-418, a high-speed bright process with moderate phosphorus content for a wide range of workloads; ENPLATE NI-419, a high-speed semi-bright process designed for high build-up and engineering applications; ENPLATE NI-424, a moderate speed high phosphorus process with a non-staining, semi-bright deposit for excellent elongation characteristics; ENPLATE NI-426 and NI-429 high hardness (58-62 Rc) low phosphorus processes with low stress designed for wear and abrasion resistance; ENPLATE NI-428, a high Teflon content process with enhanced corrosion protection and very good wear resistance; ENPLATE NI-431 and NI-433, high speed bright processes with moderate phosphorus content for high volume production at low cost.

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PHYSICAL PROPERTIES	TYPICAL RESULT
Phosphorus Content, wgt, %	10.5 to 12.0
Melting Point (eutectic)	
°C.	880
°F.	1620
Coefficient of Thermal Expansion, um/m/°C.	13 to 15
Thermal Conductivity, cal/cm/sec/°C.	0.0105
Electrical Resistivity microhm-cm	50 to 100
Magnetic Properties non-magnetic	
Hardness	
Knoop hardness (kg/mm^2)	
50 g load, 3.0 mil deposit, steel	
As Plated	450
Heat Treated @	
4 hr., 350°F. (177°C.)	480 to 520
1 hr., 750°F. (400°C.)	800 to 830
Wear Properties	
Taber Abraser Wear Test	
Index Value wgt loss mg/1000 cycles	
As Plated	15 to 18
Heat Treated @1 hr., 750°F. (400°C.)	4 to 8
Corrosion Related Properties	
Salt Spray Test* (ASTM B117)	
95°F., (35°C.) 5% NaCl, 1.0 mil deposit.	
Hours to first corrosion spot	
2024 Aluminum	1000+
1010 Carbon Steel	1000+
Nitric Acid Test	
Conc. nitric acid 42° Be', 30 sec., room temp. 1.0 mil, steel	Pass**
Hydrochloric Acid Test	
50% HCl, 3 min., room temp., 1.0 mil, steel	Pass**

* ASTM test is performed on a flat panel. More complex or rough parts may show initial spotting in fewer hours. ASTM B117 salt spray test is primarily a porosity test and is only effective as a screening tool to show the differences afforded by alternative processes. It is not a quantitative corrosion test.

** Fail is indicated by any significant discoloration of the deposit.

SOLUTION COMPONENT PROPERTIES

	NI-425A	NI-425B	NI-425C	NI-425D
Weight/Gallon (lb)	10.4	10.0	10.5	9.6
Color	Green	Colorless	Colorless	Colorless

SOLUTION MAKE-UP

MAKE-UP ADDITIONS			
	gallons per 100 gallons	**fl oz perml per gallon**	**liter**
ENPLATE NI-425A	6	7.7	60
ENPLATE NI-425B	18	23.0	180
ENPLATE NI-425C or **ENPLATE NI-425D**	- -	- -	- -
Deionized or Distilled Water	76	97.3	760

To make up the required amount of operating solution, proceed as follows:

1. Rinse tank thoroughly with deionized or distilled water.
2. Partially fill tank with deionized or distilled water.
3. Add required amounts of **ENPLATE NI-425A** and **NI-425B** with air or mechanical agitation and fill to working volume with deionized or distilled water.
4. Heat solution to 180 to 190°F. (82 to 88°C.) Check solution pH. Adjust if necessary with dilute (~50%) ammonium hydroxide or (~50%) potassium carbonate. The **ENPLATE NI-425** process normally makes up at a pH below that required for plating. If pH adjustment is not made step plating, hazing, or non-initiation of the work may result.

SOLUTION OPERATION

Solution Parameters	**Typical Range**	**Optimum Value**
Temperature, °F.	180 to 190	188
Temperature, °C.	82 to 88	87
pH	4.8 to 5.2*	4.7 to 4.9*
Solution Loading		
ft^2/gal	0.25 to 1.0**	0.25 to 0.5
dm^2/liter	0.61 to 2.45	1.23
Nickel Concentration,		
oz/gal	0.7 to 0.8	0.77
g/L	5.2 to 6.0	5.8

* Up to 5.2 for aluminum alloys.
****ENPLATE NI-425** can also be used in low solution loading situations (~0.1 ft^2/gal)

- **Plating** - After proper preparation, parts to be electroless nickel plated are simply immersed in the **ENPLATE NI-425** solution for the required time to obtain the desired thickness.

- **Agitation** - Horizontal work rod agitation and/or air agitation using a low pressure blower are recommended. Agitation during heating avoids localized overheating which can result in solution plateout. The degree of agitation depends on work load and temperature.

- **Temperature** - Faster plating rates are obtained at higher temperatures. Low temperatures should be used to retard pitting when heavy deposits are desired. Do not maintain the solution at operating temperature if work is not being processed. This will cause breakdown of the reducer and stabilizer components. Heating the solution above 195°F. (91°C.) is not recommended.

- **Filtration** - Continuous filtration is recommended. Smooth deposits require continuous 5 micron filtration medium, preferably gravity feed bag-type units. If continuous filtration is not feasible, the solution must be cooled at the end of the working period, then batch filtered through a 3 micron filtration medium before beginning the next day's work.

  Even with continuous filtration, the tank and filtration equipment require periodic leaching with 30% nitric acid followed by a water rinse and a final deionized or distilled water rinse with a small amount of either ammonium hydroxide or potassium carbonate.

- **pH Adjustment** - pH may be adjusted upward by additions of dilute (~50%) ammonium hydroxide or (~50%) calcined potassium carbonate solution. **NOTE:** If potassium carbonate is to be used for pH adjustment, consult Enthone for specific recommendations. A high purity 47% by weight calcined potassium carbonate solution is available from Enthone. Alternately, a 47% by weight potassium carbonate solution can be prepared by dissolving 5.9 lb of high purity calcined potassium carbonate in water to a volume of one gallon. Sulfuric acid, 10% by volume, may be used to lower pH. Make all additions slowly with constant stirring. When using potassium carbonate for pH adjustment, be especially careful to make additions slowly with stirring to prevent eruption of the solution due to carbon dioxide liberation. pH measurements should be made only after good agitation (and consistent solution temperature) to assure equilibrium concentration of the solution. Pehanon pH paper is recommended when instrument analysis is not being performed.

  When potassium carbonate is used to adjust pH, formation of a white crystalline precipitate (potassium sulfate) can occur in the electroless nickel solution after approximately 7 to 8 metal turnovers. This is especially true during cooling of the electroless nickel solution and is indicative of an aged solution using potassium carbonate for pH adjustment. NOTE: This precipitate is not a problem and a simple decanting procedure of the precipitate should be performed.

SOLUTION PERFORMANCE

		Typical Results
Plating Rate, mil/hr. 190°F. (88°C.)	0.4 to 0.55	
Solution Life, Turnovers*		
Steel		7 to 8
Aluminum		
• with ammoniated version **(NI-425ABD)**		4 to 6
• with non-ammoniated version and liquid K_2CO_3 used to adjust pH **(NI-425ABC)**		5 to 8
• with ENPLATE AL-100 double barrier coat	8 to 10	
Coverage, mil sq ft/gallon		
5 metal replenishments		6.90
10 metal replenishments		13.29

* One turnover occurs when the original concentration of 0.77 oz/gal (5.8 g/L) nickel metal has been replenished.

SOLUTION REPLENISHMENT

Solution replenishment (see table below) is based on the percent nickel activity of the solution. An analysis procedure for nickel and hypophosphite is available from Enthone upon request. This analysis is required to determine the replenishment amounts of **ENPLATE NI-425A** and **NI-425C.** The **ENPLATE NI-425** process can be operated as a non-ammoniated process with additions of **ENPLATE NI-425A** and **NI-425C** at a 1:1 ratio **or** can be operated as an ammoniated or self-regulating pH process with additions of **ENPLATE NI-425A** and **NI-425D** at a 1:2 ratio. In both cases, the amount of replenishment chemicals required can be determined by a simple nickel titration.

			REPLENISHMENT ADDITIONS			
% Nickel Activity	**oz/gal (as nickel metal)**	**g/L**	**NI-425A (fl oz/gal)**	**NI-425C (fl oz/gal)**	**or**	**NI-425D (fl oz/gal)**
100	0.77	5.8	---	---		---
95	0.73	5.5	0.4	0.4		0.8
90	0.69	5.2	0.8	0.8		1.6
85	0.65	4.9	1.2	1.2		2.4
80	0.62	4.7	1.6	1.6		3.2
75	0.58	4.4	2.0	2.0		4.0

1 fl oz/gal = 7.81 mL/L

- To maintain an optimum plating rate and allow for ease of replenishment, it is advisable that the nickel metal concentration not drop below 0.7 oz/gal (5.3 g/L).

- For optimum results in rack or mixed rack and barrel plating, the solution should be replenished with equal volumes of **ENPLATE NI-425A** and **NI-425C or NI-425D** as directed. Maximum recommended additions (at any one time) should not exceed 15 percent of the original metal content of the solution. If additions greater than 15 percent are required, they should be accomplished incrementally between work loads. All replenishment additions should be done with agitation.

STRIPPING

ENSTRIP® EN-79 and ENSTRIP EN-86 are non-cyanide, alkaline strippers utilizing advanced technology that dissolves electroless nickel deposits up to 5 mils thick from steel by immersion. These products are particularly effective in removing high phosphorus content deposits that could be difficult to remove with other strippers.

The expected stripping rate will range for 0.2 to 0.4 mil/hr. Solution life will vary depending upon method and condition of operation, but should hold nickel metal at the level of 2 to 4 oz. (15 to 30 g/L) per gallon of ENSTRIP EN-79 or ENSTRIP EN-86. ENSTRIP EN-79 and ENSTRIP EN-86 are also effective in stripping electroless nickel deposits from copper and copper alloys.

Proper cleaning of the part is required before stripping. Reactivation of the deposit surface with 50% HCl is recommended for parts which are carbonized and oxidized due to storage or extended service.

SOLDERABILITY

Soldering to **ENPLATE NI-425** can be effectively accomplished in a fully active flux. ENPLATE MH-320V (water soluble), and ENPLATE MH-820V (rosin flux) have been found effective in this regard. Direct soldering to electroless nickel is difficult, particularly as the deposit ages and forms oxides on the surface. If direct soldering is desired, this should be done as soon as possible after plating.

EQUIPMENT

Plating units normally used for hot acid electroless nickel solutions are suitable for use with **ENPLATE NI-425** solutions. A complete information package on equipment for electroless nickel plating is available from Enthone on request. Included is information on Enthone Electroless Nickel Plating Tanks, Electroless Nickel Controllers, and waste treatment unit for electroless nickel rinse waters.

Disposable, 8 or 12 mil thick PVC tank liners are recommended to prevent the deposition of nickel plate on stainless steel tanks. These liners are available from Enthone. Continuous anodically passivated stainless steel may also be used. Polypropylene tanks or polypropylene-lined tanks are recommended. Steam Teflon super coils or Type 316 stainless steel electric immersion heaters that are properly grounded with "over-temperature" hazard protection and/or a low liquid level device are recommended. In-tank filtration is recommended. Clean, low-pressure air agitation through bottom-mounted CPVC or polypropylene pipes is highly recommended. Clean air, free of oil and dirt is required; shop air should not be used.

Exhaust ventilation is recommended to remove steam and solution mist which are caused by agitation or gassing of the solution and which may contain nickel salts. The solution should be kept covered when it contains no work and is at or near operating temperature.

WASTE TREATMENT

Operating solutions of **ENPLATE NI-425** contain nickel and are acidic. Before disposing of the spent solution, the nickel should be removed and the pH adjusted to the regulated limits. A customer bulletin is available from Enthone detailing nickel removal. Be sure to consult local agencies with regard to regulations concerning pH limits and nickel bearing sludge disposal.

PRECAUTIONARY INFORMATION

CAUTION: ENPLATE NI-425A, NI-425B, NI-425C, NI-425D and the ENPLATE NI-425 operating solution may cause irritation.

HAZARD: ENPLATE NI-425A contain nickel sulfate, sensitivity to nickel may cause skin irritation. ENPLATE NI-425D contains ammonium hydroxide and may cause irritation. ENPLATE NI-425B and ENPLATE NI-425C and ENPLATE NI-425D contain hypophosphite and may cause irritation; heating dried salts to temperatures over 200°F. (93°C.) may produce toxic and flammable gas.

FIRST AID: In the event of contact with skin, eyes, or clothing, immediately remove all contaminated clothing including shoes and flush skin or eyes with plenty of cool, clean water for at least 15 minutes. For eyes obtain immediate medical attention. Wash clothing before reuse. If swallowed get immediate medical attention.

HANDLING INFORMATION: Always wear chemical safety goggles, face shield, rubber gloves, respirator, and protective clothing when handling ENPLATE NI-425A, NI-425B, NI-425C, NI-425D and the ENPLATE NI-425 operating solutions. When using ENPLATE NI-425D or potassium carbonate for pH adjustments make additions slowly with stirring to prevent eruption of the solution due to liberation of carbon dioxide gas. Exhaust ventilation is recommended to remove mist or vapors that may be generated during makeup and operation. Wash thoroughly after handling.

CONTAINER INFORMATION: Keep containers tightly closed. Store indoors in a cool dry area away from acids, salts, or oxidizers. Loosen closure cautiously when opening. Do not reuse containers. Wash before disposal. Improper disposal or reuse of containers may be dangerous and illegal.

REFER TO MSDS FOR FURTHER SAFETY AND HANDLING INFORMATION.

MATERIAL SAFETY DATA SHEETS

For more detailed information on the toxicological properties of the products described herein, reference can be made to the Material Safety Data Sheet (MSDS) for each product. If you do not have the proper MSDS, it can be requested from: Enthone Inc., attention: Regulatory Affairs Department, 350 Frontage Road, West Haven, CT 06516. For emergency assistance call CHEMTREC (800) 424-9300.

WARRANTY AND DISCLAIMER

The information presented herein is to the best of our knowledge true and accurate and all recommendations and suggestions appearing in this bulletin covering the use of our products are based upon information believed to be reliable. However, since the conditions of use are beyond our control, this information is given on the express condition and agreement that Enthone Inc. will not be liable to any person in contract, tort (including negligence), strict liability or otherwise for any claims, damages or losses whatsoever. Nothing herein shall be deemed a recommendation to use any product or process in violation of any existing patent rights and no warranties, expressed or implied, are made regarding the information, product, processes, recommendations, description and safety notations contained herein. The above includes proprietary information of Enthone Inc. and is furnished to you for your use solely on products or processes supplied by us to you.

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