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Technical Data Sheet

E-Brite™ 787

Ultra-Bright, Ultra-Fast Leveling Nickel Plating

E-Brite 787 is an outstanding high performance single additive bright decorative nickel plating process. It is formulated to produce exceptional leveling with an extremely bright and thin nickel deposit. It is used in applications requiring outstanding appearance with a minimum thickness of applied nickel plate. It can also be used for heavy deposit applications because it exhibits unparalleled ductility and low stress.

The process works well in both rack and barrel installations and produces white deposits which are ideal in barrel applications.

It exhibits excellent chrome receptivity.

It has an exceptional low current density bright range.

The **E-Brite 787** process is exceptionally tolerant to zinc and copper contamination. A special zinc tolerant additive system does not need to be used when plating zinc diecastings.

Generally, only one maintenance addition agent, **E-Brite 787B,** is needed to replenish the brightener and carrier components which are depleted with normal bath operation. **E-Brite 787** eliminates plating variations common with multi-additive bright nickel processes. There will be less of a chance for operator-caused imbalances of brightener and additives.

The **E-Brite 787B** maintenance brightener additive normally provides the correct amount of **EBrite 787CR** carrier. Extra additions of carrier, **E-Brite 787CR**, may be required on rare occasions if it is consumed at a higher-than-normal rate, due to changes in type of workloads or conditions of the bath or anodes. It may also have to be added following batch carbon treatment to bring the bath back into balance.

It should be noted that an **E-Brite 787** bath will maintain its outstanding ductility even if the carrier component is greatly depleted.

Running conversions from other Watts-type baths to the **E-Brite 787** process are easy to accomplish. A one (1) gallon sample of the bath should be sent to **EPI's** technical service lab for conversion recommendations. It would be helpful to send samples of the addition agents being used to determine their effect on the analysis of the bath.

Typical Bath Formulation and Operating Instructions

	Make Up	**Range**
Nickel Metal	10 oz/gal.	7.5 - 12 oz/gal.
Nickel Sulfate	38 oz/gal.	30 - 50 oz/gal.
Nickel Chloride	8 oz/gal.	6-10 oz/gal.
Boric Acid	6 oz/gal.	5-7 oz/gal.
E-Brite 787 CR	3% by volume	2-4% by volume
E-Brite 787 B	0.1% by volume	0.05 to 0.15%
E-Wet 701 W Air wetting agent, rack lines	0.1% by volume	0.05 to 0.15%
E-Wet 702 W BBL wetting agent, barrel lines	0.1% by volume	0.05 to 0.15%
pH	4.0	3.5 - 4.5
Temperature	140°F	120 - 150°F
Voltage	Rack 3-9	Barrel 6-12
Cathode Current Density-Rack	40 ASF	20-100 ASF
Cathode Current Density-Barrel	15 ASF	10-20ASF
Agitation	Air, Rod or Barrel.	
Anodes:	Electrolytic squares, R-rounds or S-Rounds in titanium baskets are recommended.	
Anode Bags:	Double cotton or napped polypropylene bags are recommended. Bags may shrink by as much as 20% and allowances should be made. Bags should be 5 inches longer than the anodes. Bags must be leached in hot water prior to use.	

Bath Make-Up

A new solution should be made up in a thoroughly cleaned storage tank which includes scrubbing the sides and bottom, followed by a hot water rinsing. The tank and filters should be leached overnight with 0.2 - 0.5% by volume sulfuric acid solution heated to 140°F. **<u>Note:</u>** At this time the anode bags to be used in the production tank must be thoroughly leached with hot water. After the storage tank is leached:

1. Fill it about two thirds full with deionized water and heat to 140°F and air agitate.
2. Add and dissolve the required amount of nickel sulfate hexahydrate ($NiSO_4$ $6H_2O$).
3. Add and dissolve the required amount of nickel chloride hexahydrate ($NiCl_2$ $6H_2O$).

4. Add nickel carbonate ($NiCO_3$) to raise the pH to 5.2.
5. Add 2 pints/100 gallons of 35% hydrogen peroxide. Dilute peroxide with DI water.
6. Add 2 lbs. per 100 gallons of activated, powdered carbon and stir for 60 minutes. Turn off agitation and allow the carbon to settle to the bottom of the tank for several hours or overnight.
7. Repack the cleaned filter with diatomaceous earth (filter aid) and carbon.
8. Filter the solution into the production tank which has been thoroughly cleaned and containing the bagged anodes.
9. Heat to 140°F.
10. Add the required amount of Boric Acid (with filter off) and air agitate until the acid is dissolved.
11. Fill tank with D.I. water to final volume and maintain temperature at 140°F.
12. Adjust pH to 4.0 with 10% by volume CP or reagent grade Sulfuric Acid.
13. With agitation and filtration on, electrolyze the solution with dummy cathodes at 5 amps/sq. ft. for 12 hours.
14. Check pH and adjust if necessary.
15. Add the required amount of **E-Brite 787 CR** and **E-Brite 787 B** and **E-Wet**.
16. After mixing for 30 minutes, commence plating.

Bath Replenishment Components, Their Functions and Control

Nickel Sulfate is the main source of nickel ions which are deposited on the work (cathode). It allows for latitude in operating current density range. Complex shapes and/or the use of higher current densities should have the higher Nickel Sulfate concentration. A low Nickel Sulfate level generally means an overall low level of nickel metal and will reduce cathode efficiency which means longer plating times to deposit a given thickness of metal. A high Nickel Sulfate level also allows for higher operating current densities which also requires a higher concentration of **E-Brite 787 B** in order to achieve quality plating. Very simple shapes or low current density applications may use a concentration as low as 25 oz/gal. Nickel Sulfate must be maintained on the basis of regular bath analysis.

Nickel Chloride, in addition to providing nickel ions to the bath, provides chloride ions to assist in the corrosion of the anodes. It increases conductivity and allows plating at higher current densities. The suggested range should be followed to prevent anode polarization and increase in **E-Brite 787 B** consumption. Higher concentrations should be avoided because they decrease ductility. Concentrations higher than those recommended may be used, but may lead to equipment corrosion problems. Nickel Chloride should be maintained on the basis of regular bath analysis.

Boric Acid stabilizes the pH at the cathode by its buffering action. It functions with the deposition of metallic nickel on the work. The correct concentration of Boric Acid retards the increase in bath pH in the solution immediately adjacent to the work (cathode). This reduces the formation of metallic hydroxides from metallic impurities which otherwise would be included in the deposit resulting in brittle or a burned plate. It’s effect is most noticeable at higher current densities where it prevents burning and pitting and provides deposit ductility and maintains the proper cathode efficiency. Concentrations greater than recommended may produce crystallization (especially at lower temperatures) which will clog filters and anode bags and cause rough deposits.

When present above its solubility, Boric Acid produces shelf roughness. The solubility of Boric Acid depends upon the concentrations of all the other constituents in the bath as well as the temperature. The easiest way to maintain the correct concentration is to hang an anode bag filled with Boric Acid in a corner of the tank. As the concentration drops in the bath, additional Boric Acid will be dissolved and will maintain the concentration just below the saturation point.

If the concentration reaches a point where roughness occurs, the solution should be cooled to 100°F and filtered to remove the excess Boric Acid.

E-Brite 787 B is the single additive brightener and leveler replenishment material. It is the only material (other than wetting agent) that is normally required. A low concentration reduces bath performance, most noticeably in the area of leveling. A slight to moderately high concentration will have little effect, other than to increase operating costs. It is consumed at a rate of approximately one (1) gallon per 10,000 to 12,000 amp hours.

The **E-Brite 787 B** contains sufficient concentration of the **E-Brite 787 CR** carrier (primary brightener) compounds to keep them in their proper concentrations. Replenishment additions should be made according to the number of amp-hours of plating done since the last addition.

The exact amount to be added depends upon the level of performance desired as well as on dragout and operating temperature.

Additions can be made periodically by hand or by means of an amp-hour pump. A pump usually insures more uniform and consistent plating quality. The **E-Brite 787 B** should be diluted three to one with water if additions are to be made by hand. The diluted material should be spread uniformly over the surface of the bath. Smaller, more frequent additions are preferred over larger, less frequent additions.

E-Brite 787 CR is the carrier, or primary brightener and is used when preparing new baths or during the conversion of an existing bath. It may also be required after batch carbon treatment.

E-Wet 701 W Air is a low foaming surfactant. It is used in either air or mechanically (rod) agitated baths. Additions of wetting agents should only be made as needed to control pitting. Use approximately 0.1% by volume. It cannot be used as a purifier for drag-in of impurities. It will not emulsify dragged in oils or grease. Too low of a concentration may result in pitting, especially in the high current density areas. A slight to moderately high concentration is not harmful but could lead to cloudy deposits.

E-Wet 702 W BBL is a wetter formulated for barrel baths as well as for mechanical (rod) agitated baths.

E-Wet Analysis

The **E-Wet** surfactants can be controlled by Hull Cell analysis or preferably by checking the surface tension of the nickel solution with a stalagmometer or a tensiometer. The surface Tension should be maintained between 30 to 35 dynes/cm. If the reading is above 35 dynes/cm. additional **E-Wet** must be added to reduce the surface tension which reduces pitting.

Bath Control and Operation

pH will rise during normal operation of the bath. Dilute Sulfuric Acid (1 part acid to 9 parts water) should be used to lower the pH. The **E-Brite 787** process will function over a wide pH range, but best results will be obtained at 4.0 to 4.2. In barrel operations, too high of a pH may lead to laminated deposits. In rack operations, too high of a pH may cause rough deposits due to metallic impurities precipitating as hydroxides at pH values above 4.5. Normally these metallic impurities (Fe, Al, Si and Cr) will be removed by the filter at a pH of 4.0 to 4.2.

In addition, too high of a pH may produce brittle deposits and reduce chrome receptivity. A low pH increases the bath's tolerance for dissolving metallic impurities, but too low of a pH can reduce leveling and brightness. The pH of a bath can be increased by stopping the additions of Sulfuric Acid and allowing the bath's pH to increase as plating continues or by adding Nickel Carbonate. Nickel Carbonate is difficult to dissolve and its addition should be avoided if possible. If it is to be added, it should be through the filter, otherwise rough deposits will result. Installations which require a large surface area of insoluble auxiliary anodes may require regular additions of Nickel Carbonate. Nickel carbonate should be slurried in with water berfore adding through the filter.

Temperature may vary over a wide range. However, it is recommended that a relatively narrow range be selected and adhered to. Wide fluctuations in temperature will affect the current being drawn at a given voltage setting and can result in poor bath performance or uneconomical operation. The use of automatic temperature control is recommended to insure a constant operating condition.

Operation at high temperatures provides for improved leveling, higher permissible current densities and greater solution conductivity. The consumption of **E-Brite 787 B** will be increased as the temperature increases.

The process can be operated at lower (120°F) temperatures, but the Nickel Chloride and Boric Acid concentration must be increased. Higher chloride is required at lower temperatures to insure proper bath conductivity. Too low of a temperature, or too low of a metal concentration, will cause high current density burning at normal amperage.

Agitation may be either low pressure, high volume air, or mechanical rod. Air agitation is preferred. Compressed air is unsatisfactory due to the possibility of introducing oil to the bath.

PVC or similar plastic pipe is recommended for supplying air to the tank. The air (holes in the pipe) should be directed at a 45° angle towards the bottom of the tank and be situated in the bath directly below the work. The volume of air should be sufficient to provide uniform movement of the solution throughout the tank, including the area around the anode baskets.

Mechanical agitation of the oscillatory type may be used at a movement rate of 3-9 feet per minute of the cathode rod. Solution agitation by an in-tank filter is not recommended.

Filtration is recommended on a continuous basis through a mixture of filter-aid and activated carbon for optimum performance. Approximately 2 lbs/1000 gal. of activated carbon should be used. The carbon should be mixed with the filter aid and precoated onto the filter. The filter should be repacked at least once a week or more frequently if unusually heavy amounts of solids or organic contamination is to be removed.

The filter should have at least one square foot of surface area for each 100 gallons of solution. The pump should be capable of turning the solution over at least twice an hour.

Filter hoses must be reinforced rubber or an approved plastic. The exit end of the actual line should be below the solution level. The returning solution should not impinge on the work, anodes or the tank bottom.

Cathode Current Density is the total current to the tank divided by the total cathode (work) surface area. **E-Brite 787** is formulated to function over a wide cathode current density, producing an extremely bright and level plate at all normal current densities. Therefore, close control is not normally required. Too high of an operating current density produces burning, while too low of a current density produces decreased plating speed. An average cathode current density of 30-40 ASF should prove to be adequate for most rack installations.

Anode Current Density is calculated by dividing the total tank current by the anode surface area. Sufficient anode area should be provided to produce a maximum anode current density of about 30 ASF (the upper limit for air agitated baths) and about 18 ASF for mechanically agitated baths.

Since the anode current density is much lower than the cathode current density range, the anode area must be many times that of the work plated.

It is impractical to attempt to maintain a specific anode current density because it is affected by so many other factors such as type of anode material, type of anode bag, amount of solution agitation, operating temperatures, nickel chloride concentration and the pH. The anode area must be large enough to dissolve anodes and replace the nickel in the solution depleted by plating. The total anode area must be large enough to keep the anodes from becoming polarized or passive. Insufficient anode area causes polarization which will produce low plate thickness and increase the consumption of **E-Brite 787B**.

Too low of an anode area produces too high of an anode current density which in addition to producing polarization, can also cause the generation of chlorine gas at the anode which reduces anode bag life and causes cracked or split bags which will introduce solids into the bath producing roughness.

Equipment

Plating tanks should be steel lined with PVC, rubber or similar materials. Smaller tanks (50-100 or less gallons) may be constructed of polyethylene or polypropylene. Fiberglass cannot be used because the plasticizers will be leached out into the plating solution. The tank should be insulated from stray current.

Treatment tanks should be the same volume and of the same materials as the plating tank and should be equipped with both air and mechanical agitation and a means of heating as most batch treatments to remove impurities are more effective at elevated temperatures and with agitation.

Temperature Control should be accomplished with constant temperature control equipment.

Heating should be by quartz, Teflon or titanium immersion heaters. The titanium should be grounded. For large installations, the bath is best heated by external heat exchangers. Immersion heating by titanium or tantalum steam coils, well insulated from electrical and stray currents, is acceptable. Lead heating coils should not be used, particularly when the bath is operated at a high chloride concentration.

Ventilation with plastic or fiberglass ductwork is recommended to remove the steam vapors which are produced.

Racks should be plastisol coated steel or copper.

Trouble Shooting

Burning

1. Too high cathode current density.
2. Improper racking.
3. Too low temperature.
4. Too low nickel concentration.
5. Too low Boric Acid concentration.
6. Insufficient distance between anodes and work.
7. Presence of organic impurities.
8. Too high of a pH.
9. Insufficient solution agitation.

Pitting

1. Too low of a concentration of **E-Wet.**
2. Organic contamination.
3. Oil and grease contamination.
4. Colloidally suspended materials.
5. Finely dispersed air coming from filters.
6. Anode bags or filters being improperly leached before use.

Roughness

1. Boric Acid precipitating.

2. Buffing grit carried into the tank.
3. Filter aid carried into the tank.
4. Airborne dirt.
5. Insufficient or no filtration.
6. Precipitating ferric or aluminum hydroxide.
7. Silicon or silicates.
8. Carbonaceous particles from torn anode bags.
9. Calcium sulfate precipitate.

Inadequate Leveling

1. Too low of a concentration of **E-Brite 787 B.**
2. Too low of a pH.
3. Too low of a temperature.
4. Insufficient thickness.
5. Low nickel concentration.
6. Organic contamination.
7. Insufficient solution agitation.

Inadequate Brightness

1. Too low of a concentration of **E-Brite 787 B.**
2. Too low of a pH.
3. Too high of a temperature in combination with inorganic contamination which affects the low current areas.
4. Inorganic contamination affects low current areas.
5. Organic contamination.
6. Poor cleaning and/or surface preparation.
7. Insufficient or poor copper under plate.
8. Insufficient solution agitation.

Dark or Gray Low Current Density Deposits

Copper or zinc contamination

Brittle Deposits

1. Too low of a temperature.
2. Too low of a nickel content.
3. Organic metallic impurities.
4. Too high of a current density.
5. Too high of a concentration of **E-Brite 787 B**.

Poor Coverage

1. High zinc contamination.
2. Poor cleaning.
3. Lead contamination.

Contamination with inorganics comes from drag-in from strike or pickle solutions, from make-up salts and water, metallic dust, dissolution of metal parts dropped into the tank, pigments from rack coatings and improper choice of equipment or anodes.

Copper, zinc, chromium and lead impurities produce a haze.

Iron, calcium, aluminum and silicone impurities produce roughness as they exceed their solubility. They precipitate a deposit of “stardust” or salt and pepper appearance.

Most inorganic impurities affect the low current density areas with a cloudy deposit. Processes operated at high overall current densities will have a greater tolerance to these impurities. Work with deep recesses will be more susceptible.

Severe **iron contamination** can be precipitated out by oxidation at a high pH. However, normal iron contamination will be removed by filtration.

Copper, Zinc and **Lead** are removed by high pH treatment or low current density dummy plating at 2 to 5 amps/sq. ft. Additions of up to 0.1% of **E-Brite 787 Purifier** will temporarily overcome the effect of these contaminants and will improve the low current density area appearance and coverage.

Chromium in the hexavalent form will reduce the cathode efficiency and cause spotty and poorly adherent deposits. The addition of Sodium Bisulfite, Hydrosulfite or Thiosulfate will reduce the hexavalent to the harmless trivalent form. For complete removal, treatment with lead carbonate at a high pH is required.

Calcium will build up in the bath as make up water is added to the bath. Roughness will result when the solubility of Calcium Sulfate is exceeded. At approximately 104°F the maximum solubility will be reached. Filtration at higher than normal operating temperatures or cooling below 104°F and filtering will correct the problem.

It is desirable that D.I. water be used for make up water.

Aluminum and **Silicon** may be removed by raising the pH to 5.2 and heating the solution to 150°F or higher for 24 hours and then filtering the solution.

Organic contaminants come from the decomposition of addition agents, untreated anode bags or filtering materials leached from tank lining, hoses or other coatings, or from buffing compounds, oils and lubricants left on improperly cleaned work. They also come from the drag-in of cleaning solutions, solvents, copper plating additives, and drippings from overhead equipment.

Organic Contaminates are removed by carbon absorption. The bath should be continuously filtered through activated carbon. Severe contamination will require a batch carbon treatment at elevated temperatures.

Bath Control

1. The pH should be checked daily with a pH meter and adjusted if required.
2. The major bath components should be analyzed frequently as described below.
3. The level of **E-Brite 787B** can be determined empirically by in-plant Hull Cell tests or by submitting a sample to **EPI**.

Bath Analysis

Nickel Metal

1. Pipette 2 ml. bath sample into a 250 ml. Erlenmeyer flask.
2. Add 20 ml. of 50% Ammonium Hydroxide and about 1/2 gram of Murexide Indicator and swirl to dissolve.
3. Titrate with 0.1M EDTA until the color changes from yellowish-green or brown to a deep bluepurple at the end point.

Nickel Metal oz/gal. = ml. of EDTA x 0.39

Nickel Chloride

1. Pipette 2 ml. of bath sample into a 250 ml. Erlenmeyer flask.
2. Add 100 to 150 ml. of D.I. water
3. Add 5 to 8 drops of Potassium Chromate Indicator.
4. Titrate with 0.1 N. Silver Nitrate until the color changes from clear yellow to a brick red color.

Nickel Chloride oz/gal. = ml. of $AgNO_3$ x 0.8
Chloride oz/gal. = ml. of $AgNO_3$ x 0.24

Nickel Sulfate

Nickel Sulfate oz/gal. = [A-(B x 0.25)] x 4.5
A= oz/gal. of nickel metal B = oz/gal. nickel chloride

Boric Acid

1. Pipette a 2 ml. bath sample into a 250 ml. Erlenmeyer flask.
2. Add 40 ml. of 12% Mannitol solution
3. Add 8 to 10 drops of Bromocresol Purple Indicator.
4. Titrate with 0.1N Sodium Hydroxide solution until the color changes from yellow-green to a pale blue at the end point.

Boric Acid oz/gal. = mls. of NaOH x 0.42

Preparation of Reagents and Indicators

0.1 m EDTA: Dissolve 37.2 grams of EDTA (Ethylenediaminetetraacetic acid, Disodium Salt) in distilled water and dilute to 1 liter.

0.1 N Silver Nitrate: Dissolve 17 grams of Silver Nitrate in distilled water and dilute to 1 liter. **Note:** The Silver Nitrate should be dried in an oven to free all moisture.

0.1 N Sodium Hydroxide: Dissolve 4 grams of Sodium Hydroxide in distilled water and dilute to 1 liter. Standardize before using.

Murexide Indicator: It is available from most laboratory chemical suppliers.

Potassium Chromate Indicator: Dissolve 20 grams of Potassium Chromate in distilled water and dilute to 100 mls.

Mannitol Indicator: Dissolve 12 grams of Mannitol in 100 ml. of distilled water.

Bromocresol Purple Indicator: Dissolve 0.1 grams of Bromocresol Purple in 100 mls of Methanol.

Caution and First Aid

Inhalation of the vapors or fumes may be irritating to the upper respiratory tract. Nickel salts in crystalline form or water solution can be irritating to the eyes and skin. There may be “nickel itch” noted in some workers handling nickel salts. Prevention of skin contact is the best way to avoid the problem.

Adequate measures must be taken to protect workers from eye or skin contact and to prevent the inhalation of fumes. The use of the following protective equipment is recommended: chemical safety goggles or face shield, rubber gloves, protective clothing and shoes. Work in a well ventilated area or provide general purpose respirators. Wash thoroughly after handling chemicals and at the end of the work period. Launder contaminated clothing before re-use.

In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. If irritation persists get medical attention. For inhalation, move exposed individual to a non-contaminated area. Get prompt medical assistance.

NOTE: A Material Safety Data sheet (MSDS) furnished by **EPI** must be read and understood prior to working with **E-Brite 787B, 787CR, E-Wet 701 W Air, E-Wet 702 W BBL** and **787 Purifier**. MSDS’s may be obtained from your suppliers for Nickel Chloride, Nickel Sulfate, Nickel Carbonate, Boric Acid and Sulfuric Acid.

PACKAGING

E-Brite 787B, **787CR, 701 W Air, 702 W BBL** and **787 Purifier** are available in one (1), five (5) and 55 gallon non-returnable containers.

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.**