

Electroless Nickel And Electroless Krome Plating

Acid Nickel Process: 5-7% phosphorus

These instructions now cover the Nickel and the Krome kits. Electroless Krome is a nickel/cobalt alloy, harder and bluer than nickel. Where these instructions refer to Electroless Nickel, this also means Electroless Krome. The only difference in the kits is the part A component, which, in the case of Krome, has the cobalt additive. You may use parts B & C for either type of plating, as they are completely interchangeable.

Electroless nickel/krome plating requires no anodes, power supply or electrical connection of any kind. The process simply involves mixing together some solutions, heating them to just off the boil, and then immersing the part to be plated. An auto-catalytic electrochemical reaction takes place and the nickel is evenly deposited all over the part being plated. The thickness of the plate will depend on the duration of immersion. To stop the reaction, the part is removed from the solution, which is allowed to cool before storing for later reuse.

Commercial electroless nickel platers usually employ full time chemists to make additions to the solution. This is a time consuming activity for a small operation and is not cost effective. Our system is designed around the KISS -'Keep It Safely Simple' principal, so you will not have to 'titrate' and mess around with this technicality. We have developed a straightforward way of estimating the nickel depletion of the bath, and fresh additions can easily be made to prolong the life of the solution. The procedure is much like balancing your checkbook.

The brightness of the plate will, to some extent, depend on the degree of polish existing on the part. The higher the shine initially; the brighter the plate. Surfaces requiring shiny finishes should be done in fresh batches of solution; otherwise they may have to be buffed to obtain a high gloss. The duller finishes resemble cadmium or Butler nickel, so are of great value to most vehicle restorers. Numerous variations can be achieved by changing the surface finish prior to plating.

Electroless nickel plating is not new; it has many applications in industry. Because the system plates evenly over all areas of the part, even down tubes and holes, it is frequently used for firearms and small hand tools. It is ideally suited for coating extrusion dies to assist in mold release and protection of the surface. For the motorcycle restoration enthusiast, electroless nickel has a great application for evenly plating the air-cooling fins on many engine blocks, particularly older Indians and Harleys.

Fortunately, electroless nickel is a fairly safe material, nevertheless, there are heavy metals (nickel) in the solution and this should not be disposed of carelessly. Our kits have a special system included to 'plate out' the excess nickel, rendering the rest of the solution harmless, enabling you to dispose of down a drain, or as per your local regulations.

The system consists of 3 main ingredients, parts A, B & C.

Mix parts A & B with distilled water to make up the initial solution. As this is depleted of nickel, further additions of part A and part C are made to keep the solution stable and plating brightly.

Plating Copper and Copper Alloys

Parts made from copper and copper alloys need to be in contact with a piece of steel, in the solution, for approximately 5 minutes so that the auto-catalytic reaction will start. Once the reaction starts (part will start to gas), you can remove the steel. Some customers prefer to hang these parts into the solution from a piece of steel wire.

What is a 'Nickel Credit'?

The level of nickel metal in the solution must never be let to drop below 80% of its initial level. If it does, the bath will crash and will be rendered useless. Therefore, we must monitor and replenish the amount of nickel in the tank as you plate your parts.

Nickel credits are a term we use to keep track of the nickel level in the tank.

Depending on the volume of plating solution, you start out with a number of credits. In our mini kit (5 pint), you have 1800 credits to start.)

Credits are used when you plate a part. To calculate credits used, you multiply the surface area in inches by the time you are plating.

The time you are plating, determines the plating thickness. 30 minutes of plating time give a coating that is 1/2 mil thick (0.0005")

Let's practice a few calculations:

Example 1

You have a part that is 5"x5" square, and flat, that you need to plate. That's 25 square inches per side, or 50 square inches total.

You want 0.0005" of nickel plating on the part, requiring a 30 minute plating time.

You will use $50 \times 30 = 1500$ nickel credits

Example 2

You have a cube shaped part that is 3"x3"x3". That's 54 square inches in area.

You want 1 mil of thickness, requiring 60 minutes plating time.

You will use $54 \times 60 = 3240$ nickel credits

Ok, so we understand how credits are used, but how are they replenished in the plating system?

Replenishment

In our Standard Electroless Nickel Kit (10 pint bath), we start out with 3600 nickel credits. This is based on the volume of chemicals in the tank. A kit twice the size would have twice the credits to start.

Using Example 1 above, we would use 1500 nickel credits during plating, so $3600 - 1500 = 2100$ nickel credits left after plating. Easy, right?

BUT - we MUST remember that at no time can the amount of nickel credits in the bath get below 80% of their initial level, or the bath will crash. 80% of the original $3600 = 2880$ credits.

So, if we plated this part for the entire 30 minutes, the bath would have crashed and would be useless.

So, how can we plate this part? Simple.....we must add replenisher during the plating.

Using Example 1 above, we know that we will use 1500 nickel credits during the 30 minute plating time.

We know that we must replenish after we use up 80% of the original credits ($80\% \text{ of } 3600 = 2880$)

We know that credits are calculated as time x area.

We can work out that if the part is 50 square inches, we will lose 720 credits after 14 minutes.

($720/50=14.4$)

Therefore, we must add replenisher every 14 minutes to bring the bath back up to it's original level.

(To replenish 720 credits, we add 1froz of part A and 2froz of part C)

We will need to do this every 14 minutes, so during a 30 minute plating cycle, you will replenish twice.

Ok, let's try with Example 2:

In a Standard Electroless Nickel Kit we start with 3600 credits.

Your part is 54 square inches in area.

How many credits will you use during the entire plating time of 60 minutes?

At what credit level do you need to replenish?

After how many minutes should you replenish?

How many times?

Answers:

60 mins x 54 sq in = 3240 credits

80% of the beginning 3600 = 720 credits

720 credits, divided by 54 sq inches = 13.3 minutes (13 is ok)

3240 credits used / 720 credits each time = 4.5. If you replenish 4 times, once every 13 minutes, you'll have added 2880 credits out of the 3240 used, so at the end, add half a replensihier to give you back the balance of 360 credits.

Maximum Load

Another consideration when electroless plating is Maximum Load. A certain volume of electroless plating solution can only plate a part that is a certain area or less. Parts bigger cause the autocatalytic reaction to fail.

In the mini 5 pint kit, the max load is 75 sq inches. If your part is bigger than that, you'll need a larger volume of plating solution to plate it.

Plating Solution Volume	Max Load
5 pint	75 sq in
10 pint	150 sq in
20 pint	300 sq in
40 pint	600 sq in

Making Up The Electroless Nickel or Krome Solution

READ MSDS AND WEAR ALL PROTECTIVE GEAR

Tank Setup For 5 Pint Mini Kit

For 10 Pint Kit, multiply by 2

For 20 Pint Kit, multiply by 4

For 40 Pint Kit, multiply by 8



Degreasing Tank

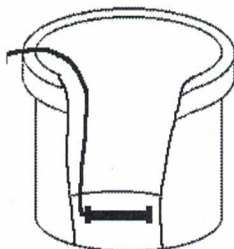

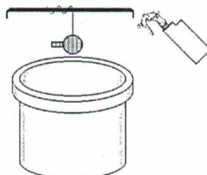




1. In one of your enamel tanks, add 5 pints of distilled water.
2. Add 5 oz of SP Degreaser Powder
3. Place on a range or hotplate and heat and mix well. Degreaser works best at hot temps

Plating Tank

Making up the Electroless Nickel Plating Solution

1. Add 4 Pints of Distilled Water to your enamel tank
2. Add 4 oz Part A Electroless Nickel or Krome Plating Solution
3. Add 12 oz Part B Electroless Nickel/Krome Plating Solution
4. DO NOT ADD PART C NOW. Save this for replenishment
5. Add entire bag of Mist Control Balls. They help retain heat in the tank.
6. Mark liquid level on tank with permanent marker.
7. When ready to electroless nickel plate, heat solution to 195 deg F on range or hotplate
8. Monitor temperature with glass heater

Refer to the chart on the following page for plating steps.

PROCEDURE	SETUP	OPERATING PARAMETERS	EQUIPMENT	SAFETY																																				
1. SURFACE PREPARATION	Buff & Polish for a mirror finish. Bead Blast for a 'flat' finish. Nylon Abrasive wheel buff for a 'scratched brush' look.																																							
2. DEGREASING		140- 200F No agitation 5 mins immersion 1 oz SP Degreaser per 1 Pint of distilled water per	1 x Enamel Lined tank 1 x tank lid 1 x 2lb SP Degreaser																																					
3. RINSE IN DISTILLED WATER SPRAY																																								
4. WATER BREAK TEST	 Oil/dirt film makes water bead up		 No oil/dirt film allows water to cover part																																					
5. CALCULATE TOTAL SURFACE AREA AND PLATING TIME REQUIRED 6. CALCULATE CREDITS THAT WILL BE USED 7. CHECK MAXIMUM LOAD NOT EXCEEDED 8. CHECK FOR COPPER ALLOY (PART MUST BE CONTACTED WITH A PIECE OF STEEL FOR 2-5 MINS) 9. PREMIX REPLENISHER IF REQUIRED																																								
10. TANK MAKEUP		<ul style="list-style-type: none">195°F (Heat on hotplate or range)Add bag of mist balls Per 5 pints of plating solution required: 4oz A, 12oz B, 4 pints distilled water MARK LIQUID LEVEL	<ul style="list-style-type: none">1 x Enamel Tank1 x Tank lidMist BallsElectroless Parts A & BDistilled water	Wear rubber gloves and goggles. Do not ingest. 																																				
11. PLATING TIMES	Time 15 mins 30 mins 60 mins	Application Indoor items, decorative etc Hand tools, guns, nuts, bolts, brackets Marine, motorcycle, car or outdoor fitting	Plate Thickness 0.00025" 0.0005" 0.001"																																					
12. REPLENISH	<table><tr><th>Tank Size</th><th>Max Load (Sq In)</th><th>Starting Credits</th><th>Replenish Before Using (Credits)</th><th colspan="2">Replenisher Make Up</th></tr><tr><td></td><td></td><td></td><td></td><th>A</th><th>C</th></tr><tr><td>5 pint</td><td>75</td><td>1800</td><td>360</td><td>0.5 oz</td><td>1 oz</td></tr><tr><td>10 pint</td><td>150</td><td>3600</td><td>720</td><td>1oz</td><td>2 oz</td></tr><tr><td>20 pint</td><td>300</td><td>7200</td><td>1440</td><td>2 oz</td><td>4 oz</td></tr><tr><td>40 pint</td><td>600</td><td>14400</td><td>2880</td><td>4 oz</td><td>8 oz</td></tr></table>				Tank Size	Max Load (Sq In)	Starting Credits	Replenish Before Using (Credits)	Replenisher Make Up						A	C	5 pint	75	1800	360	0.5 oz	1 oz	10 pint	150	3600	720	1oz	2 oz	20 pint	300	7200	1440	2 oz	4 oz	40 pint	600	14400	2880	4 oz	8 oz
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13. TOP UP	After adding replenisher, top up with distilled water to original level. Avoid adding large amounts of water that will decrease temperature of bath.																																							
14. BUFF & POLISH	Buff and polish to enhance the finish, using white buffing compound or Blue Begone Polish																																							

Electroless Nickel Plating Troubleshooting

Problem	Cause	Remedy
No deposit	No current (or gassing from part) Incorrect solution ratio Copper alloy not activated	Incorrect bath temperature, increase temp Dump solution and make up fresh batch Touch copper alloys with steel rod for 5-60 seconds until part starts to gas
Plate peels off or blisters	1. Poor preparation 2. Inadequate cleaning 3. Organic or metallic contamination 4. Improper zincating of aluminum	Check part with 'water break' test. Acid etch part. Check SP Degreaser is OK. Rework the part through the cleaning process Dump solution and make a fresh bath. Etch zincate off in mild acid, and re-zincate in fresh solution.
Pitted Plate	Impurities in solution Copious evolution of hydrogen gas	Dump solution and make up a fresh bath Surface are being plated should be reduced. If tank walls are gassing, they may be being plated. Clean tank
Rough Plate	Contamination of loose particles i.e.: dust nickel. Contaminated water used Particles of metal or soil on work	Filter solution through a doubled coffee filter. Discard solution and make up new batch using DISTILLED water Improve cleaning and rinsing process.
Dark deposits (esp. on low spots)	Zinc, lead or copper in solution	Plate out onto a dummy corrugated cathode. Zinc contaminants may show as alternating dark & lights areas. Air agitation must be on Adjust pH to 3.5 - 4.5
Streaks in Deposit	Gas streaks from position of work Poor agitation. Poor rinsing & or cleaning Metal & organic contamination Low surface area	Reposition work occasionally Agitate occasionally Improve cleaning and rinsing process Dump solution and make up fresh batch Increase the number of parts being plated
Poor corrosion/chemical resistance	Metallic contamination	Dump solution and make up fresh batch
Dark to black deposits	Metallic/organic contamination (usually caused by old zinc plate) Bath imbalance	Dump solution and make up fresh batch Soak part in weak solution of muriatic acid to remove old zinc plate
Poor wear resistance	Low heat treatment temperature &/ or short time	temperature and time cycle should be adjusted
Laminar deposits	Poor temperature	Keep temp within range
Frosted deposits	Low work load Metallic/organic contamination	Increase work load Dump solution and make up fresh batch
Poor Adhesion on Aluminum	Metallic/organic contamination Improper surface preparation Improper zincate or other pre-treatment Improper heat treatment Re-oxidation	Dump solution and make up fresh batch Improve cleaning and rinsing process Replace zincate bath heating time and temperature should be corrected Reduce transfer time from zincate to nickel
Dull or matte deposit	bath more than 25% used Metallic/organic contamination Poor quality substrate Low temperature	Make up fresh batch -or- buff the part to a shine solution and make up fresh batch Improve polishing etc Correct the temperature
Poor coverage, edge pullback & frosted edges	Improper cleaning &/or rinsing Metallic/organic contamination	Improve cleaning and rinsing process Dump solution and make up fresh batch
Plating solution turns white	Solution is depleted	Solution may be contaminated with alkaline drag in. Dump solution
Plating solution turns grey	Solution is decomposing	See above. Prevent drag in. Dump solution
Part A has hard deposit in bottom	Caused by solution temperature dropping below 50 deg F	The deposit contains the nickel, and MUST be re-dissolved into the solution Simply heat up the liquid to 150 F and stir until dissolved.

Electroless Nickel Tips & Tricks

ONLY ADD ENOUGH REPLENISHER TO BRING YOUR CREDITS UP TO 100%

You may add the replenishment solutions at any time. After a wait of approx. 20 seconds, to allow the solution to warm up to its operating temperature, top up the solution to the original waterline with DISTILLED WATER.

You may make as many as 10 (x 20%) COMPLETE additions of replenishment to the bath. Your additions will be noted on your 'Nickel Credits' form. After this, you should dispose of the solution and make a fresh bath with parts A & B.

A note on bath replenishment.

During the process of plating, a quantity of water will evaporate from the tank. Additions of DISTILLED WATER must be added periodically to maintain the correct dilution of the solution. Make a note of the waterline when you first make up your solution. To make an addition, first, IF REQUIRED, add a quantity of REPLENISHMENT SOLUTION, then top up with distilled water. It is always advisable to add small amounts of both distilled water and replenisher frequently, say every 5 minutes, as this will keep the bath from cooling and becoming unstable.

NICKEL CREDIT FORM

Surface Area in Square inches	Time In Minutes	Nickel Credits Used	Credits Added	Balance
			STARTING BALANCE=	

Chemical Disposal Procedure

Add enough household ammonia to make the plating solution turn blue. Heat to 170 deg f. Using 1 steel pad per liter of solution, immerse them into the solution.

Add the END concentrate at the rate of 20 ml per liter of solution.

Heat the bath to 190-205 deg F approx. 1-2 hours until the solution turns water white.

The solution is now drain safe and can be disposed of.

Tank Size In pints	Quantity of Steel Pads	END In Fl oz
1-2	1	0.5
8-12	4	4
24	12	8

Advanced Users /Titration Procedures

For Reference Only

For the advanced user who wishes to measure and replenish the bath more exactly, we have included instructions. Caswell Inc does not offer technical support on this procedure.

Bath Replenishment:

To ensure proper operation of the Electroless Nickel system, the solution chemistry must be maintained between 85% and 105% of initial activity. This is accomplished by measuring and monitoring the nickel metal concentration via a standard EDTA titration.

Upon determination of the nickel metal concentration, additions of both Part A and Part C are made based on the following calculation and/or replenishment guide.

Replenishment Calculation:

fl.oz/gal of Part A = (.8 - oz/gal Ni in bath) x 7.2

fl.oz/gal of Part C = (.8 - oz/gal Ni in bath) x 14.4

Replenishment Guide [100 gallon Bath]

% Activity*	Nickel Conc. oz/gal & (g/l)	Part A	Part C
100	.80 (6.0)	0	0
95	.76 (5.7)	0.9 qts	1.8 qts
90	.70 (5.3)	1.8 qts	3.6 qts
85	.68 (5.1)	2.7 qts	5.4 qts
80	.64 (4.8)	3.6 qts	7.2 qts
75	.60 (4.5)	3.6 qts	7.2 qts ⁽²⁾

EDTA Titration For Nickel

The titration steps for total nickel and explanation follow.

1. Pipette a 10.0 mL sample from bath. This amount is critical since we will measure the number of molecules in this sample and use the sample size to compute the weight of those molecules (grams) per unit of volume (liter). Any error in the sample size will cause an error in the computation of nickel metal concentration.
2. Dilute with ~50 mL of DI water. This measurement is not critical because the amount of nickel in the sample is unaffected by the dilution.
3. Add 10 mL of concentrated ammonium hydroxide. Ammonium hydroxide serves as a buffer in the pH range of 9 to 10. The pH of the solution is critical since H^+ ions compete with the nickel ions to complex with the EDTA molecule.
4. Add a pinch of murexide indicator to pale straw color. 100 grams of murexide indicator is a mix of 1 gram murexide and 99 grams NaCl. The murexide complexes with nickel ions to form the yellowish nickel-murexide complex.
5. Titrate with 0.1M EDTA to a purple endpoint. At the endpoint, the nickel ions are complexed with the EDTA leaving the purple murexide free. Each EDTA molecule wraps up a Ni^{++} ion, taking it out of solution. The total nickel per liter of 1.0M EDTA is then 58.71 grams - the molecular weight of Ni. Conversion to our sample size of 10 mL and titrant molarity gives $0.1 \times 58.71 \text{ g/L} / 10 \text{ mL} = .5871 \text{ g/L}$ nickel per mL of 0.1M EDTA titrant.