Bright Nickel Plating Process

Bright Nickel VX-1265 process is a new development for an optimum, fast levelling, high performance Bright Nickel system.

FEATURES

(i) High brightness and levelling.
(ii) Good activity and receptivity to Chromium plating.
(iii) Good low current density brightness and coverage.
(iv) High tolerance to Zinc and Copper contamination.
(v) Faster rate of deposits useful for low and high thickness of Nickel.
(vi) Lower operating cost.
(vii) Stable brightener system

APPLICATIONS

VX-1265 Nickel Plating process is used for decorative plating either:

(i) for single layer bright nickel or 
(ii) as the top layer of a duplex nickel system where improved resistance is required.

This process can be used on different base metals such as steel, brass and copper and, if a previous layer of copper is deposited from a cyanide based process, it can also be used on Zinc and Zinc alloy components. It can also be used for plating Aluminium and Aluminium alloys after suitable pretreatment.
The brightener system can be used with air agitated or cathode movement nickel plating solutions based on watts type formulations; useful for Barrel and Vat type Bright Nickel plating. The plating solutions should be filtered continuously over activated carbon to assist in the removal of undesirable organic contamination.

**BATH COMPOSITION – MAKE-UP**

<table>
<thead>
<tr>
<th>Component</th>
<th>Optimum</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bright Nickel salt BN-64</td>
<td>350 gm/litre</td>
<td>300 – 400</td>
</tr>
<tr>
<td>gm/litre</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nickel Additive 502</td>
<td>9.0 ml/litre</td>
<td>8 – 10ml/litre</td>
</tr>
<tr>
<td>Nickel Brightener VX-1265</td>
<td>0.3 ml/litre</td>
<td>0.2 – 0.6 ml/litre</td>
</tr>
</tbody>
</table>

**Operating Conditions**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Optimum</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density</td>
<td>24° Be</td>
<td>21 - 26° Be</td>
</tr>
<tr>
<td>pH (Electrometric)</td>
<td>4.8</td>
<td>4.5 – 5.0</td>
</tr>
<tr>
<td>Temperature</td>
<td>50° C</td>
<td>40 - 60° C</td>
</tr>
<tr>
<td>Cathode Current Density</td>
<td>4 Amp/dm²</td>
<td>2 - 8</td>
</tr>
<tr>
<td>Amp/dm²</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anode Current Density</td>
<td>2 Amp/dm²</td>
<td>1 - 3</td>
</tr>
<tr>
<td>Amp/dm²</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anodes</td>
<td>“S” Nickel chips, Electrolytic nickel or rolled carbon nickel</td>
<td></td>
</tr>
<tr>
<td>square, cast</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anode Bags</td>
<td>Double bags of cotton or napped polypropylene</td>
<td></td>
</tr>
<tr>
<td>Agitation</td>
<td>Air or cathode rod</td>
<td></td>
</tr>
<tr>
<td>Filtration</td>
<td>Continuous</td>
<td></td>
</tr>
</tbody>
</table>

**SOLUTION PREPARATION**

The solution should be made up in a storage tank which has been thoroughly cleaned. All dirt, grease, etc. should be wiped off and the tank side and bottom scrubbed with a wetting agent and hot water, then thoroughly rinsed. The lining
Solution preparation steps are:

1. Fill treatment tank two-third full of water & heat to 60$^\circ$C.
2. Add the necessary Bright Nickel Salt BN-64.
3. When the constituents have dissolved, raise the pH to 5.2. This is accomplished by adding Nickel Carbonate to the fresh nickel solution with vigorous stirring.
4. Allow to cool to 60$^\circ$C or lower.
5. Add (20 vol.) hydrogen peroxide in the proportion of 4 ml/litre of solution.
6. Heat to 65$^\circ$C and stir vigorously for one hour.
7. Add activated Carbon 3 – 4 gm/litre of solution. Stir intermittently for four hours then allow to settle overnight.
8. Filter this solution into the cleaned and leached plating tank.
9. Clean and repack the filter with Nickel Purifier and activated carbon in 1:1 proportion (50 gm each).
10. Adjust the pH to 4.5 (Electrometric) with dilute Sulphuric acid (C.P or Technical grade).
11. Electrolyse at low current density 0.2 – 0.5 Amp/dm$^2$ using corrugated dummy cathodes. Air agitation should be used during electrolysis. Continue electrolysis for approx. 12 – 16 hours or until recesses in corrugated cathodes are light in colour. The filter should be run continuously during electrolysis.
13. Top up with water to full volume.

CONVERSION OF EXISTING BATHS

It is possible to convert most bright nickel processes to Bright Nickel VX-1265 process. It is also advisable to forward a sample of addition agents being used to determine their influence on analytical results.

SOLUTION OPERATION AND CONTROL

ROLE OF SOLUTION CONSTITUENTS

pH

Lustra Nickel process deposit is bright over a wide pH range 4.5 - 5.0. At the higher end of the range i.e., 4.5 – 5.2 the levelling property is at its optimum. Too high pH decreases the ductility of the deposit and causes roughness by the precipitation by hydroxides. Iron and Aluminium precipitates in this range, so these impurities will cause “stardust” or “salt and pepper” deposits.

The pH is maintained by regular additions of AR Sulphuric acid. If at any time it becomes necessary to raise the pH, then the use of Nickel Carbonate or Sodium hydroxide solution is recommended.
Temperature

The normal operating temperature of the Bright Nickel VX-1265 process is 55°C. Higher operating temperature gives better levelling and ductility. At high temperature if the impurity level increase above the tolerance level of the process, haze will form in the low current density areas. If the bath can not be purified immediately it is advisable to lower the operating temperature temporarily. Steam heating coils of seamless nickel, stainless steel, titanium or other resistant metals can be used. For smaller tanks, quartz immersion heaters are preferred.

Current Density

The process operates over a wide cathode current density range. Satisfactory deposits are obtained in the range 2 – 6 Amp/dm$^2$ but an average current density of 4 Amp/dm$^2$ would be normally used.

Agitation

In the operation air agitation is preferred. A low pressure blower is recommended as air supply. Compressed air is not recommended because of the danger of oil contamination of the solution; oil cause pitted and cloudy deposits.

Anode

“S” Nickel chips or electrolytic nickel squares in titanium baskets are recommended. These anodes assure the plater of satisfactory anode corrosion. If the anode current density becomes excessive, polarisation will result and brightener consumption will increase. The maximum anode current density should not be greater than 1 Amp/dm$^2$. Baskets should always be kept full of chips.

Anode Bags

Double or napped polypropylene bags are recommended. These should be leached prior to use to prevent their contaminating of the nickel solution by the sizing etc. in them.

Water

In hard water area it is strongly recommended that deionised or distilled water should be used for additions to maintain the correct working level of the solution. This will prevent rapid accumulation of calcium salts which may crystallise and block the small holes in the air agitation coil.
EQUIPMENT

Tank

Mild steel tank lined with approved quality of semi-hard rubber.

Heaters

Fused silica cased heaters, impervious graphite heat exchangers or Titanium steam coils can be used for heating the solution.

Filter Unit

All the parts of the filter coming in contact with the solution should be either approved rubber, plastic lined or stainless steel of 316 type. The size of the filter should be selected such that the initial filtering rate per hour will be at least double to the volume of the tank. A carbon pack of 0.1 – 0.3 gm/litre on the filter is satisfactory to help for maintaining brightness and uniformity.

SOURCES OF CONTAMINATION

Sources are salt and make-up water, metallic dust, drippings from tank rods, dissolutions of metal dropped into tank, accidental additions of wrong salts, pigments or occluded solution in rack coatings, drag-in from strike solution or pickles, improper choice of accessory equipment and improper anodes.

ORGANIC IMPURITIES IN SOLUTION

Sources of organic contamination like decomposition of addition agents due to anode polarisation, untreated anode bags, material extracted from tank linings, connecting hose, filter or rack coatings, paint or buffing dusts in the vicinity of the plating tank, buffing compounds, oils or lubricants left on improperly cleaned work, and drag-in cleaners, solvents, copper plating addition agents, etc.

REMOVAL OF CONTAMINANTS

ORGANIC

The removal of organic contamination is accomplished by carbon absorption. It is recommended that the bath solution be continuously filtered through carbon. Approximately 0.25 gm/litre will be satisfactory to keep up with moderate contamination. If the contamination is severe, more frequent or larger carbon packs will be necessary. At times a simple activated carbon treatment may be necessary.
INORGANIC

The most troublesome haze-producing metallic impurities are copper, zinc, chromium, and lead. Iron, calcium, aluminium, and silicon are roughness producing impurities. As they exceed their solubility, they precipitate and give the deposit a “stardust” or “salt and pepper” appearance. Since most of these contaminants appear as low current density clouds, a piece of work with a deep recess will be more susceptible than that simply shaped part. Iron is precipitated by oxidation at high pH. Because of the high operating pH and the use of air, iron is continuously being removed from the bath solution by filtration.

Copper and Zinc are removed by use of nickel purifier along with carbon in filter pack. Chromium when present in hexavalent form, lowers the cathode efficiency and causes a spotty and poorly adherent deposits.

Calcium will build up in the bath as water is added to replace evaporation losses. Roughness will result as the solubility of calcium Sulphate is exceeded. Calcium Sulphate will precipitate in the air line orifices if hard water is used. It is desirable in hard water areas to use a demineralizer.

Aluminium and silicon may be removed by filtration at a pH of 5.2 or higher.

MAINTENANCE

Nickel Sulphate

The compound provides the nickel ions for the solution. The concentration of nickel Sulphate is a factor which largely determines the efficiency. It is recommended, therefore, that minimum concentration of nickel Sulphate is maintained at 250 gm/litre. Higher the concentration of nickel ions, higher will be permissible current densities. Lower salt level may reduce speed of deposit.

Nickel Chloride

The chloride ion is important in that it enables the anodes to dissolve correctly without polarisation, and it improves the electrical conductivity of the solution. Nickel chloride also increases the tolerance of the solution to zinc contamination. Decrease in chloride concentration causes anode polarisation which oxidizes some brightener resulting in cloudy deposits. Chloride in excess of 70 gm/litre will adversely affect the ductility of the deposit and is never recommended.

Boric Acid

Boric acid acts as a buffer to maintain the pH of the bath within a certain range. It also serves to minimize the electro deposit stress. The recommended concentration is 45 gm/litre. At concentrations above 45 gm/litre there is a danger of precipitation if the solution drops below $43^\circ$ C. This will result in rough deposit and clogging of the air agitation system. On the other hand too low boric acid concentration will result in burning in high current density areas and more rapid change of pH. It maintains brightness, adhesion, and ductility. Low
concentration may produce pitting, burnt H C D, and rapid pH changes. Its concentration should be checked once a week and should be 45 gm/litre.

**Nickel ADDITIVE 502**

The main function of 502 is to give extra levelling action and to control stress. It is very effective at low to high current density range. Addition of 502 is recommended where the maximum “Levelling” is required. The concentration of this additive should be maintained by adding 150 – 200 ml per 1000 ampere hours. Batch carbon treatment partially removes the additive and hence should be made up by adding 25 ml per 100 gm of activated carbon.

**NICKEL BRIGHTENER VX-1265**

VX-1265 has been formulated to give outstanding brilliance levelling, tolerance to impurities and ductility. VX-1265 can alone be used for initial make up as well as maintenance of the bath. Initial concentration is 0.6 ml/litre. Consumption of this brightener is approximately 100 – 150 ml per 1000 ampere hours when used along with 502 at the recommended level. It is recommended that 502 and VX-1265 be used together to obtain maximum levelling without impairing the ductility of the deposit. Carbon treatment partially removes this brightener and hence should be made up by adding 50 ml per 100 gm of activated carbon used.

**Rate of Deposition of Nickel**

Time required in minutes for deposits at various current densities based on 98 % cathode efficiency.

<table>
<thead>
<tr>
<th>Thickness Microns</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>25</td>
<td>12.5</td>
<td>8.4</td>
<td>6.3</td>
<td>5.0</td>
<td>4.2</td>
<td>2.5</td>
</tr>
<tr>
<td>10</td>
<td>50</td>
<td>25.0</td>
<td>16.7</td>
<td>12.5</td>
<td>10.0</td>
<td>8.4</td>
<td>5.0</td>
</tr>
<tr>
<td>15</td>
<td>75</td>
<td>37.5</td>
<td>25.0</td>
<td>18.8</td>
<td>15.0</td>
<td>12.5</td>
<td>7.5</td>
</tr>
<tr>
<td>20</td>
<td>100</td>
<td>50.0</td>
<td>33.4</td>
<td>25.0</td>
<td>20.0</td>
<td>16.7</td>
<td>10.0</td>
</tr>
<tr>
<td>25</td>
<td>125</td>
<td>62.5</td>
<td>41.7</td>
<td>31.3</td>
<td>25.0</td>
<td>20.8</td>
<td>12.5</td>
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<tr>
<td>30</td>
<td>149</td>
<td>74.5</td>
<td>49.7</td>
<td>37.3</td>
<td>29.8</td>
<td>24.8</td>
<td>14.9</td>
</tr>
<tr>
<td>40</td>
<td>199</td>
<td>99.5</td>
<td>66.4</td>
<td>49.8</td>
<td>39.8</td>
<td>33.2</td>
<td>19.9</td>
</tr>
</tbody>
</table>
**TROUBLE SHOOTING IN NICKEL PLATING**

### Burning
1. Too high cathode current density
2. Improper Jigging
3. Too low temperature
4. Too low nickel concentration
5. Too low boric acid concentration
6. Insufficient anode cathode distance
7. Presence of organic impurities
8. Too high pH
9. Improper air agitation

### Inadequate Levelling
1. Too low concentration of brightener VX-1265 and leveller 502
2. Too low pH
3. Too low temperature
4. Insufficient thickness
5. Organic contamination
6. Low nickel concentration

### Pitting
1. Too low antipit concentration
2. Organic contamination
3. Inorganic contamination
4. Oil and grease contamination
5. Colloidally suspended materials
6. Finely dispersed air aspirating through Pump or filter
7. Too low pH
8. Poor distribution of air

### Lack of Normal Brightness
1. Too low concentration of VX-1265
2. Too low pH
3. Too high temperature in the presence of Inorganic contamination
4. Inorganic contamination
5. Organic contamination
6. Poor base metal preparation

### Roughness
1. Airborne dirt
2. Carbonaceous particles (torn anode bags)
3. Calcium sulphate precipitations
4. Boric acid precipitations
5. Silicon and silicates
6. Buffing grit
7. Ferric hydroxide and aluminium hydroxide precipitations

### Lack of Normal Ductility
1. Too high concentration of brightener VX-1265
2. Too low temperature
3. Too low nickel content
4. Presence of organic and inorganic contamination
5. Too high current density
6. Oxidation products due to anode polarisation