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NICKEL COATING COMPOSITION AND METHOD OF COATING

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NICKEL COATING COMPOSITION AND METHOD OF COATING

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The invention relates to coating surfaces with nickel and more particularly relates to a process of spray metallizing conductors and non-conductors with chemically reduced nickel.

An object of this invention is to provide a simple and inexpensive process of providing a smooth, uniform coating of nickel.

These and other objects and advantages are accomplished by spraying an aqueous solution of nickel sulphate (preferably the hydrated nickel sulphate, NiSO$_4$·6H$_2$O) containing citric acid in a molar ratio of nickel sulphate to citric acid of between approximately 1.3 to 2.0 in conjunction with a reducer solution in such a manner that the solutions converge on the article to be coated. In place of nickel sulphate, there can be used nickel chloride or nickel formate, in a molar ratio of such salts to citric acid of 1.3 to 2.85.

The reducer solution which we have found to give the most satisfactory results with the above mentioned nickel solutions is as follows:

<table>
<thead>
<tr>
<th>Grams per liter of aqueous solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium hydroxide</td>
</tr>
<tr>
<td>Sodium hydrosulphite</td>
</tr>
<tr>
<td>Sodium hypophosphite</td>
</tr>
</tbody>
</table>

The molar ratio of hydrosulphite to hypophosphite to obtain the best results must be between 1.40 to 3.59. The ratio of metal solution to reducer solution can be varied widely. We have found that particularly good results are obtained with equal volumes of metal solution and reducer solution.

The following table shows the effect of varying the molar ratio of nickel sulphate (NiSO$_4$·6H$_2$O or NiSO$_4$) to citric acid on the thickness of nickel film:

<table>
<thead>
<tr>
<th>Ratio</th>
<th>Thickness, mils</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.18</td>
<td>0.008</td>
</tr>
<tr>
<td>2.00</td>
<td>0.040</td>
</tr>
<tr>
<td>1.77</td>
<td>0.042</td>
</tr>
<tr>
<td>1.60</td>
<td>0.048</td>
</tr>
<tr>
<td>1.32</td>
<td>0.033</td>
</tr>
<tr>
<td>1.06</td>
<td>0.000</td>
</tr>
<tr>
<td>0.80</td>
<td>0.000</td>
</tr>
</tbody>
</table>

We obtained satisfactory results with concentrations of nickel sulphate (NiSO$_4$·6H$_2$O) of from 15 to 20 grams per liter and citric acid of between 8 to 12 grams per liter, the molar ratios of nickel sulphate (NiSO$_4$·6H$_2$O) to citric acid being as stated above, i.e., 1.3 to 2.0. The above compositions can, of course, be sold in much more concentrated solutions, or even in a dry state and then diluted with water to make them suitable for the process of this invention.

The temperature of the solutions during processing can be varied widely. However, the temperature limit of the reducer solution is about 140°F., as above this temperature it starts to decompose. Suitable temperatures are approximately 70°F. to 140°F. for reducer solutions, and 70°F. to 180°F. for the metal solutions.

For cold spraying of plastics, that is, temperatures of 60°F. to 100°F., we obtain preferred results by sensitizing the plastic surface with 2 to 10 grams of SnCl$_2$ per liter of aqueous solution, preferably containing .5 to 2 grams per liter of sodium lauryl sulphate, or other fatty alcohol sulphate. The plastic is then rinsed with 2 to 10 grams of silver nitrate per liter of aqueous solution, and then preferably containing .5 to 2 grams per liter of sodium lauryl sulphate or other fatty alcohol sulphate; then without rinsing, the plastic is sprayed with the nickel salt solution.

For metals or hot spraying of plastics, the results are about the same without the sensitizer.

In general, the higher the temperature is, the faster is the rate of deposition and the thicker and more opaque the coating.

The spray application can be done by air atomization of solutions, air pressure feed of spray nozzles, or hydraulic pressure in spray nozzles.

The following example is given to illustrate the invention:

A specific solution make-up is as follows:

**Metal solution:**

NiSO$_4$·6H$_2$O | 3 lb., 5.5 oz.
Citrnic acid | 1 lb., 11 oz.
Water to make 1 gallon

**Reducer mixture:**

NaOH | 1 lb., 5.5 oz.
Na$_2$SO$_4$ | 11 lb., 11.5 oz.
NaH$_2$PO$_4$ | 1 lb., 11 oz.

The one gallon of metal solution is diluted to 20 gallons for spraying. The dry reducer mixture is also dissolved in water to give 20 gallons of solution.

As a specific example of nickel metal coating for electrolyzing, we spray the above solutions separately at 140°F. at 12 p.s.i. for approximately 5 minutes on a Vynilite mold, backed by a cool metal plate to conduct away the heat.

We have obtained satisfactory results on copper, aluminum, stainless steel, steel, brass, and plastics. So far as we know, all types of articles can be nickel coated with our solutions.

Instead of using a spray process, the article can be coated by dipping into a solution formed by mixing the nickel solution and reducer solutions, agitating the solutions, and then removing the coated article. This procedure is not as fast and does not give a coating which is quite as uniform as the spray process.

In order to facilitate ready comprehension of this invention and certain aspects of the method and means included within the purview of the same, a non-limiting example of apparatus or applying device useful for practicing some of the principles of the invention is illustrated in the accompanying drawing.

While we have disclosed certain preferred embodiments of our invention, many modifications thereof may be made without departing from the spirit of the invention; and we do not wish to be limited to the detailed examples, formulas, and proportions of ingredients set forth, but desire to avail ourselves of all changes within the scope of the appended claims.

We claim:

1. A process of coating a surface with nickel which comprises spraying separately and directing toward the surface so that the solutions converge on the surface a nickel solution and reducer solution, said nickel solution consisting essentially of a nickel salt, selected from the group consisting of nickel sulphate, nickel chloride, and
3. Nickel formate; water, and citric acid in a molar ratio of nickel sulphate to citric acid of between approximately 1.3 and 2.0, and a molar ratio of such other nickel salts to citric acid of between approximately 1.3 and 2.85 and said reducer solution consisting essentially of an alkaline solution of sodium hydrosulphite and sodium hypophosphite, the molar ratio of sodium hydrosulphite to sodium hypophosphite being between approximately 1.40 and 3.53.

4. The process of claim 1, wherein the surface is an organic plastic sensitized with stannous chloride prior to coating and the temperature of the solutions is from 60°F to 100°F.

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