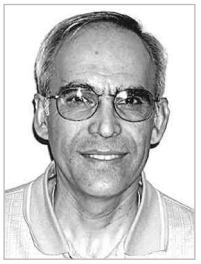
Finisher's Think Tank



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The Right Additives for Bright Nickel Plating

Ever since Schlotter and associates identified and developed organic additives for nickel plating in the 1930s, the process has improved dramatically. Replaced was time consuming buffing to achieve bright nickel deposits. Bright, leveled nickel deposits could now be readily obtained directly from the standard Watts nickel solution. Platers also shared in the joy of using anti pitting agents to prevent gas pitted deposits, which until then were a major problem. The basic or foundation additives for nickel plating have changed very little over the years.

During the past decades researchers have found new and "hotter" additives, thus promoting even higher degrees of overall brightness and leveling. At the same time, unique compounds were found to aid in purification and tolerance of the nickel bath to impurities, even to permit production use.

Much has been learned about nickel plating additives by process development, field applications, and troubleshooting. This has, in turn, supported continued research and development. It should be acknowledged that bright nickel plating is the predominant type of nickel plating for a variety of industrial and consumer products. This covers a broad range that includes: automotive, aerospace, aircraft, personal goods, appliances, electronics, medical devices, safety equipment, construction, and entertainment.

How Big is Nickel Plating?

Lets consider this year's "tale of the tape." In 2005, the worldwide consumption of nickel anodes for plating will be 258 million lb. That figure is up 3.1% compared to 2004. For the curious, stainless steel remains the largest consumer of nickel. Just imagine the quantity of nickel additives that are required to meet the demands of plated finishes. Let us review some of these types of nickel additives and addition agents.

Types of Additives

The types of nickel additives are primarily organic compounds, many are classified as unsaturated (contain double and triple bonds for the organic chemists), sulfur containing, and reacted to some degree. Several of these additives are sodium salts of organic acids, enabling them to be water soluble. They range from very stable at the temperature range of bright nickel plating, 130–145°F (54–63°C), to highly volatile. Except for the wetting agents and some purifiers, most of these organic additives co-deposit with nickel, preferably in specific current density ranges. Brighteners, levelers, stress reducers, grain refiners, anti pitting agents, and purifiers, comprise the main types of addition agents. Until about 20 years ago, certain brightener and leveler components were very sensitive, in that a lack of sufficient purity would cause their additions to compromise the preferred ductility of nickel deposits. Improvements in the synthesis and purification of these additives have extensively eliminated this problem.

Foundation Brightening Agents

Class I Brighteners

There are two in this classification. The first contains sodium saccharin, a universally acknowledged and accepted additive. It is very useful and helpful to the nickel plating process. The benefits to the deposit include: promoting ductility (relieving stress), grain refinement, and high current density brightness. Compared to other brightener additives, it plates out slowly. It is also not very sensitive to removal by carbon filtration. Proprietary products in this group may be referred to as "carrier" or "stress reliever." Carrier is a very important additive with regard to deposit ductility. Many nickel plated parts, upon subsequent finishing, may be mechanically stamped, bent, or twisted in the fabrication of finished parts. As complete products containing other components, the carrier concentration in the bright nickel bath may range from 2–5% by volume.

The second contains a unique double bonded organic sulfonate compound. It promotes low current density brightness and works in conjunction with the maintenance brightener. The additive also helps to extend bright throw of the nickel deposit and promote sufficient low current deposit thickness. For flash chrome plating this is very important, because it extends the effective chrome coverage. This additive is sometimes referred to as an "indexing" brightener, or "index." By the application, the index plates out more readily in the low current densities and is somewhat carbon sensitive. The type of bright nickel plating has an effect on the optimum index concentration in the nickel bath. For example, the plating of wire goods will expose a great deal of low current densities. This will require the working concentration of finished brightener indexing products to be about 1.2–2.5% by volume. To nickel plate parts containing a uniform range of current densities, the index containing brightener may range in concentration from 0.5–1.5% by volume.

Class II Brighteners

These may typically include organic substituted diols that contain double or triple bonded carbon. Class II brighteners are "hotter," in that they promote rapid over-

all brightness and leveling of the nickel deposit. These addition agents are usually consumed the quickest, due to their overall co-deposition. Class II brighteners are the main components in finished products that also contain some of each of the previously described Class I brightener agents. These products are usually consumed at the rate of one gallon per 8,000–12,000 ampere hours. To maintain the desired overall characteristics of the nickel deposit, frequent additions may be required during the production schedule. This is readily facilitated by automatically dosing the brightener product. This is accomplished by interfacing an addition pump with an amp hour meter, that has been programmed to activate the pump. Care must be taken to maintain the desired addition rate of product. Too little will result in dull, poorly leveled deposits. An excess will lead to deposit brittleness and poor low current density deposit (dark, lack of coverage). Excesses can be corrected by dummy electrolyzing, carbon filtration, and addition of Hydrogen Peroxide.

Another type of the "hotter" brighteners are the organic pyridine containing compounds. These additives provide a quick fix, in that relatively thin deposits can be obtained with exceptional brightness and leveling. These Class II brightener agents also contain some of the Class I materials in the finished product. Their use or application are similar to the previously described agents, only the activity is much more pronounced. The pyridine containing brighteners enable, where possible, for a thinner nickel deposit to meet aesthetic specifications. This, in turn, can be a huge savings when factoring in the current market pricing for nickel anodes and salts. Excesses of pyridine containing brightener products expose a unique problem. Dull mid to low current density deposits will not readily respond to dummying, carbon filtration, or the addition of strong oxidizers (hydrogen peroxide or potassium permanganate). Purifiers in the form of specific reducing agents must be added to clear up the deposit. Sometimes these additives are referred to as "brightener reducers."

There is another Class II brightener that contains substituted alcohols. These additives also promote rapid brightness and leveling. However, due to their volatility, booster adds to the nickel bath are necessary. This includes periods of bath inactivity.

Anti Pit Wetting Agents

Additives to prevent gas pitting

These are specific surfactant blends, that reduce the surface tension of the Watts nickel solution, thereby eliminating pitting due to the formation of hydrogen gas bubbles. It has been determined that maintaining the surface tension of the nickel solution from 35–40 dyne/cm^2 will prevent hydrogen gas pitting. Rack air agitated plating baths require low foaming anti pit agents. Barrel and rod agitated rack or still baths require surfactants that happen to be higher foaming. The higher foaming anti pit is also a good emulsifier for oils and grease that may have contaminated the nickel bath. In either case the anti pit product concentration may range from 0.25–1.2% by volume. These additives do not plate out, but are consumed through solution drag out loss and by carbon filtration.

Additives to prevent pitting due to fine particulates

One type of additive is a mixture of organic agents that disperse fine particulates, thus preventing their adhesion to parts during plating. It will facilitate the action of filtration, to help clear up the solution. These addition agents are consumed by drag out and are carbon sensitive.

Additives to prevent pitting due to iron contamination

Reducing agents and complexors react chemically with ferric iron (Fe3+), that is precipitated in the bath as fine particles. The additive concentrate will reduce the iron to the ferrous state (Fe2+) and complex it, to prevent it from plating out in the deposit. Sometimes these are referred to as iron control agents. Product additions of 0.5–1 oz/gal for maintenance purposes may be sufficient. It is usually applied where there is a heavy emphasis on the plating of tubular steel, connectors, and fasteners.

Purifiers

Metallic contaminants and brightener excesses may wreck havoc with production plating schedules. If not, the quality of nickel plated work will probably be compromised.

Metallic impurities, zinc and copper, can be rapidly and effectively addressed to maintain uninterrupted nickel plating. The important consideration is that contamination is not excessive, to render the additives relatively useless. In this regard, 10-100 ppm can be handled. The purifiers depolarize the cathode film on the plated surface, allowing the contaminant to plate out over a wide current density range. It results in a preferable "white" nickel deposit, especially in the effected low current density areas. The product concentrate contains the purifier agent along with a small amount of brightener, leveling agent. 0.1–0.5% by volume addition ranges may be required for effective corrective action. Purifiers are not meant to be regular plating additives. Rather, these are considered to be service products. If frequently used, the product is being miss-used or the source of contamination is not being properly addressed.

Iron control agents have been described in the previous section. Brightener reducing agents have also been previously described. *P&SF*

Answers to I.Q. Quiz #413

1. Titrate (The others are chemical names.)
2. Ferrous/ferric (The others are electrodes.)
3. Electrical resistance (The others are mechanical properties.)
4. Cyanide (The others are nickel plating chemistries.)
5. Aluminum (The others are plated from aqueous solution.)