Stephen F. Rudy, CEF
Enequist Chemical Co.
100 Varick Avenue
Brooklyn, NY 11237
718/497-1200
E-mail: sfrudy@aol.com

Beat the Heat—Keep it Cool

Temperature can affect process performance

The seasons continually change, so we now find ourselves in the midst of summer. No matter where we go, or what we do, the heat's on. Being prepared for the increase in temperature can prevent trouble.

Personal comfort requirements may include turning on the AC, making more trips to the sea shore or mountains, drinking cold refreshments, and just plain "chillin."

But, don't overlook those workhorse plating and surface finishing lines that make our livelihood possible. Temperature dependency and tolerance acutely affect some process and conditioning baths. In fact, the majority of these baths provide some form of chemical reaction on parts. There is a critical relationship between temperature and chemical reactions. Along with contributing parameters, the chemical reaction rate increases as the bath temperature increases. A familiar correlation is the old standby soak cleaning statement: "For every 20 degrees increase in bath temperature, the cleaning action to remove organic soils will approximately double."

Keeping it "Just Right"

In most shops and installations, the effects of rising temperatures can be encountered in baths that really like it not too hot or not too cold, but just right. That is why refrigeration units, such as chillers and cooling coils are so important. Sometimes the equipment is operating in good order for a particular bath. If it's not working correctly, repairing or replacing it may be in order. Another possibility is simply overlooking the fact that temperature control is so important, especially during the summer.

Let's take a "dip" in some finishing baths to test those waters. Please keep in mind that room temperature does vary with the changing seasons. It is better and more accurate to measure temperatures and make adjustments to keep within a specified range. Examples are given for most processes. Proprietary systems may require different ranges, but the importance of adherence to temperature remains consistent.

Plating baths do generate heat based on the passage of electrical current. Therefore, it becomes even more important to maintain selected baths within the operating temperatures, especially the cooler running systems.

Acid Copper

Bright plating baths usually operate at 70–90°F (21–32°C). Elevated temperatures will result in higher consumption of brightener and leveling agents. Dullness, especially in the low current density, can become a problem. Aside from increased operating costs per ft^2 of deposited copper, the co-deposition of more organics may affect desired softness of the deposit for post plate buffing. The deposit may become more passive, affecting adhesion to subsequent plated layers, such as nickel.

Chromium—Hexavalent

Range: 90–120°F (32–49°C). This process is typically affected by temperature and chromic acid-to-sulfate ratio. If the desired plating temperature gets higher, poor throw will become evident. Until adequate cooling can take effect, it may be helpful to increase the ratio.

Chromium—Trivalent

Range: 70–130°F (21–54°C). There are two commercial baths, chloride and sulfate based. Higher temperatures can result in darker deposits. High current density skip plating and reduced low current density coverage may also occur.

Watts Bright Nickel

Even though the bath temperature range is 135–145°F (57–63°C), I am including this system, based on the types of additives that comprise it. Higher temperatures will increase conductivity, thereby, developing a thicker deposit. This can be a problem in high current densities where burning and noduling can occur. Most proprietary nickel additive systems contain certain organic agents that become more volatile (boil off quicker as the bath temperature rises). Replenishing these additives will increase the plating cost. Higher temperatures also result in thermal oxidation of nickel additives, forming organic contaminants. These, in turn, detrimentally affect the operating bath and characteristics of the nickel deposit. The appropriate temperature control is important for the nickel bath, not only during the summer, but for all seasons.

Zinc

There are three commercial baths with which to plate. Ranges are given as follows:

- Acid Chloride: 70–125°F (21–52°C)
- Alkaline Non Cyanide: 65–115°F (18–46 °C)
- Cyanide: 65–115°F (18–46°C)

Higher temperatures will result in deposit dullness in the three systems. Each process requires organic additives, such as grain refiners, brighteners, and wetting agents. Higher temperatures necessitate increased additions of these materials, thereby, increasing the cost of plating. The possibility of deposit blistering increases. Occlusion of higher levels of organics in the zinc deposit will affect chromating.

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children, infants, and fetuses at an increased health risk from environmental chemicals, either because they have a heightened susceptibility to such compounds or because they experience higher relative exposures to environmental chemicals than do adults? The exhaustive evaluation of the data carried out by the book's authors concludes there is no scientific evidence to support the claim that children are necessarily more vulnerable to all environmental chemicals." [8]

Other publications support these conclusions. A recent study by Reason Public Policy Institute finds that children generally are not more susceptible to chemical toxicity than adults, and that where differences do occur they are small. The report, *Protecting the Children: Risk Assessment, Risk Management, and Children's Environmental Health* by Gail Charnley[9] also concludes that there is little evidence that environmental exposures play a significant role in childhood disease.[10]

Despite expenditures of $100 to $140 billion each year on environmental health protections and compliances, government agencies still have very little idea which environmental exposures actually pose risks to children. Thus, *Protecting the Children* recommends focusing future research on known threats to children's health and assessing our ability to reduce those risks in a meaningful way.[10]

Helen Roberts and her co-authors of *Children At Risk* report that almost half of all deaths among children aged 1–19 in the United Kingdom in 1990 were caused by injury and poisoning. They note: "Given the sheer extent of the child accident problem it is at best curious—at worst scandalous—that accident risks have not given rise to the same public concern that other aspects of children's well-being have elicited. Why is it that the major cause of childhood death in the UK does not attract more attention from scholars, policy-makers and the public?"[11] Obviously, the same question could be asked about actions in the U.S.

NEWSWEEK in a special report on children noted that parents seem more worried about rare but well publicized diseases, such as Lyme disease, West Nile virus and SARS, but they rarely ask about car seats or smoke detectors. "They outfit their kids with GPS locators and child identification kits, but not with properly fitting bicycle helmets. They know details about crimes in other states, but seem not to notice their own children's weight problems."[12] And while on the subject of weight, public health officials have been stressing that childhood obesity is definitely life threatening and difficult to treat. Fifteen percent of children—9 million kids—are seriously overweight, a rate that has tripled since 1970. These kids are on the fast track for adult cripplers like heart disease, stroke and diabetes.[13]

Summary

Concern over child susceptibility is increasing at a time when ecosystem health is improving and human exposure to environmental chemicals is declining.[14] Environmental chemicals are only one type of hazard that children and infants may face and they often pale in comparison to other children's health risks, such as automobile and bicycle accidents, sports injuries, drowning, and accidental poisoning. Understanding and giving proper attention to real children's health risks, versus those risks that are hyped into fears, is critical so that environmental chemical risks can be seen in the proper perspective and children's health can be maintained.[15]

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Finisher's Think Tank

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This in turn reduces corrosion protection and service life of finished parts. Desired metal distribution in the deposit will also be affected. Throw in the non-cyanide bath will be reduced. Elevated temperature in the cyanide zinc bath will hasten the thermal oxidation of cyanide to carbonate. This will gradually reduce plating efficiency.

Chromates

The various colors typically operate in a range of 70–90°F (21–32°C). As the bath temperature increases, the chromate film that forms becomes thicker and less adherent. Immersion time can be decreased, if this is practical, to compensate for elevated operating chromate temperatures. Trivalent chromates are another possible alternative. The chromating reaction for trivalent chromates is usually slower compared to the hexavalent. Some trivalent chromates require higher temperatures, or tolerate them better than the hexavalent chromates.

Zincates

Temperature range: 65–85°F (18–29°C). Conventional zincates, based on zinc oxide and caustic soda, are the oldest technology of the available types. Conventional alloy zincates consist of zinc and iron. Modified alloy zincates are composed of four metals: zinc, copper, iron, and nickel. Each system is affected by increasing temperature. The conventional zincates and alloys are more sensitive to increasing temperature. The rate of zincate formation increases as the temperature does. At a certain film thickness, the zincate becomes spongy, porous, and less adherent to the aluminum surface. This results in poor quality plating. The parts may have to be scrapped or stripped and polished before rework. Modified alloy zincates form a matrix of the four metals in the film. The action of copper and nickel is to control film thickness, with better tolerance to higher zincate bath temperatures. But, there is no substitution for maintaining the correct temperature range.

The months of June, July, and August typically contribute to the unwelcome heating effect that will keep baths warm and warmer. Sufficient temperature control and adequate cooling of temperature sensitive baths not only becomes important, but downright critical.

Beat the heat—keep it cool! Thanks to Bob Lynch of Atotech USA for his helpful comments.