TOC Key to Bright Nickel Purity

by
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Today's demands for high quality bright, level and ductile nickel deposits are greater than ever. Automotive and the motorcycle industries have set the pace for this increased quality. One has only to look at a new Harley Davidson and calculate the square footage of nickel/chromium it displays to prove the point. They know that nickel/chromium sells bikes. In addition to factory bright work, very few bikes leave the dealer without adding an additional $2,000.00 to $3,000.00 of plated accessories. Square footage has increased on automobiles, and the trend is continuing. Top-line freight carrying tractors sport large nickel/chromium grilles. This backs up a phrase I have used for years - "Nickel Is Class."

Producing this high quality requires that plating baths be in chemical balance and a high state of purity. The inorganic balance is simple. However, the organic purity has always been a guessing game. We know that an organically clean bath produces the ideal deposit. As contamination increases, efficiencies decrease. For metallics, removal is simple: oxidize, precipitate or electroplate them out. Organic contamination presents a more complicated problem. Organic contaminants are difficult, if not impossible, to identify. The source of origin may be from insufficient cleaning, impacted polishing compound remaining in holes and crevices, and soils on the parts that are carried into plating baths. In addition to drag-in contaminants, there are breakdown products produced by the electrolysis of additives.

Traditional methods

Traditional treatments for organic contamination have been the bi-annual carbon treatment during Christmas and Fourth of July shutdowns. Plating baths are treated mainly because of the seasons. When questioned why, the usual response is, "It really can't hurt." Standard carbon treatments consisted of pumping the bath to storage, dumping in carbon, mixing well and letting it settle; filter back into the plating tank and you're ready to go. If we thought the bath was really contaminated, we dumped in some hydrogen peroxide and maybe even potassium permanganate. Now we've cleaned up all the bad stuff - or have we? I have run Hull cell tests on baths before and after these holiday rituals and found very little difference. They did remove all of the wetting agents. Carbon treatments are costly, first in the loss of solution ranging from 5 to 10%. Second is labor, which is usually done on overtime. Third is the replacement of additives removed.

TOC (Total Organic Content)

Today, with the aid of TOC analysis, we are able to determine the total amount of organics both good and bad, and maintain purity. TOC analysis offers the ability to track organic contamination and treat when needed with confidence of cleaning up the bath. Plating baths consist of both inorganic and organic materials. Maintaining these materials in a state equal to a new bath's values, we can produce plating equal to that value.

Knowing the TOC of a new and clean bath we may surmise that an increase is from contaminants, we can now take the proper action. Consider the typical values for three common nickel baths and the organic additives used (in the bottle) in Table 1.

Table 2 gives the typical TOC values for the individual components for a freshly, made-up bright nickel bath (in the tank).

Table 1
Typical TOC values for newly prepared nickel baths and for additive products

Nickel Bath TOC Values for a New Bath, ppm*	
Bright Nickel SAS base	5,000 ppm
Semi-Bright Nickel	500 ppm
Microporous Nickel	3,000 ppm
Organic Additives	
Secondary brightener SAS (0.1%)	677 ppm
Secondary brightener PPS (0.1%)	72 ppm
Primary brightener (1.0%)	648 ppm
Carrier brightener (1.0%)	700 ppm
Wetting agent (0.25%)	170 ppm
Purifiers (0.1%)	48 ppm
Dispersing agent (0.125%)	112 ppm
City tap water	11 ppm
*Values between vendors may vary slightly.	

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Organic contaminants

As the bath is used, organic contaminants inevitably build-up. Table 3 lists some oif the most common sources and their effects.

Removing organic contaminants

Now that we know what we are looking for, a proper carbon treatment may be conducted.

A newly made-up PPS bath will have a TOC of about 3,000 ppm. The normal operating range would be 3,000 to 25,000 ppm. We would conclude from this that a TOC value of over 25,000 ppm would constitute a bath in need of purification. High levels of brightener, wetters and purifiers will raise the TOC levels and must be factored in. They will fall into the range of good TOC levels. Assuming the additives are at their proper concentration and the TOC is over 25,000 ppm, the bath would be in need of purification.

TOC analysis would eliminate performing a carbon treatment because of the season. By conducting Hull cell tests in conjunction with TOC analysis, a proper treatment may be conducted. Factors involved in proper carbon treatments consist of carbon, hydrogen peroxide, potassium permanganate and pH. Organics are removed at specific pH levels with varying amounts of oxidizing agents. They are then absorbed by carbon.

By treating a sample of the contaminated bath according to the following conditions, followed by a Hull cell test, we can determine the exact treatment required.

1. Straight carbon at an operating pH of 4.00
2. Straight carbon at a low pH of 3.00
3. Carbon treat with hydrogen peroxide high and low pH
4. Carbon treat with potassium permanganate high and low pH.

By performing TOC analysis on each treated sample, the most effective treatment may then be performed with confidence of removing all harmful organics. We have discussed the value of TOC testing on nickel plating bath. TOC may be used on any plating bath where organic additives are used.

A one time analysis of TOC of a plating bath may tell the organic content, be it high or low. The real value of TOC is to use it as a tracking device of organic contamination, as in Figure 1. A weekly analysis informs you of purity levels as they rise and fall. As you observe these trends you may act accordingly, performing treatments as needed.

Table 2
TOC contributions from components in a freshly prepared bright nickel bath

TOC Contributors	TOC Value, ppm
Nickel metal, Ni	0
Nickel sulfate, $NiSO_4$	0
Nickel chloride, $NiCl_2$	0
Boric acid, H_3BO_3	0
Primary brightener (4.00 vol%)	2,592
Secondary brightener (0.20 vol%)	144
Carrier brightener (2.00 vol%)	1,400
Wetting agent (0.20 vol%)	340
Dispersing agent	0
Purifiers	48
Additive breakdown products	0
Miscellaneous	0
City water (York, PA)	11
Total TOC of a new bright nickel bath	**4,535**

Table 3
Sources of organic contaminants and their effects in nickel plating

Organic Contaminant	Effects
Oils	Pitting, blotches, poor adhesion
Greases	Pitting, blotches, poor adhesion
Polishing compounds	Pitting, blotches, poor adhesion
Additive breakdown products	Clouds, haze, pitting, stardust, poor chromium receptivity, drop-off of step and decrease in additive efficiency.

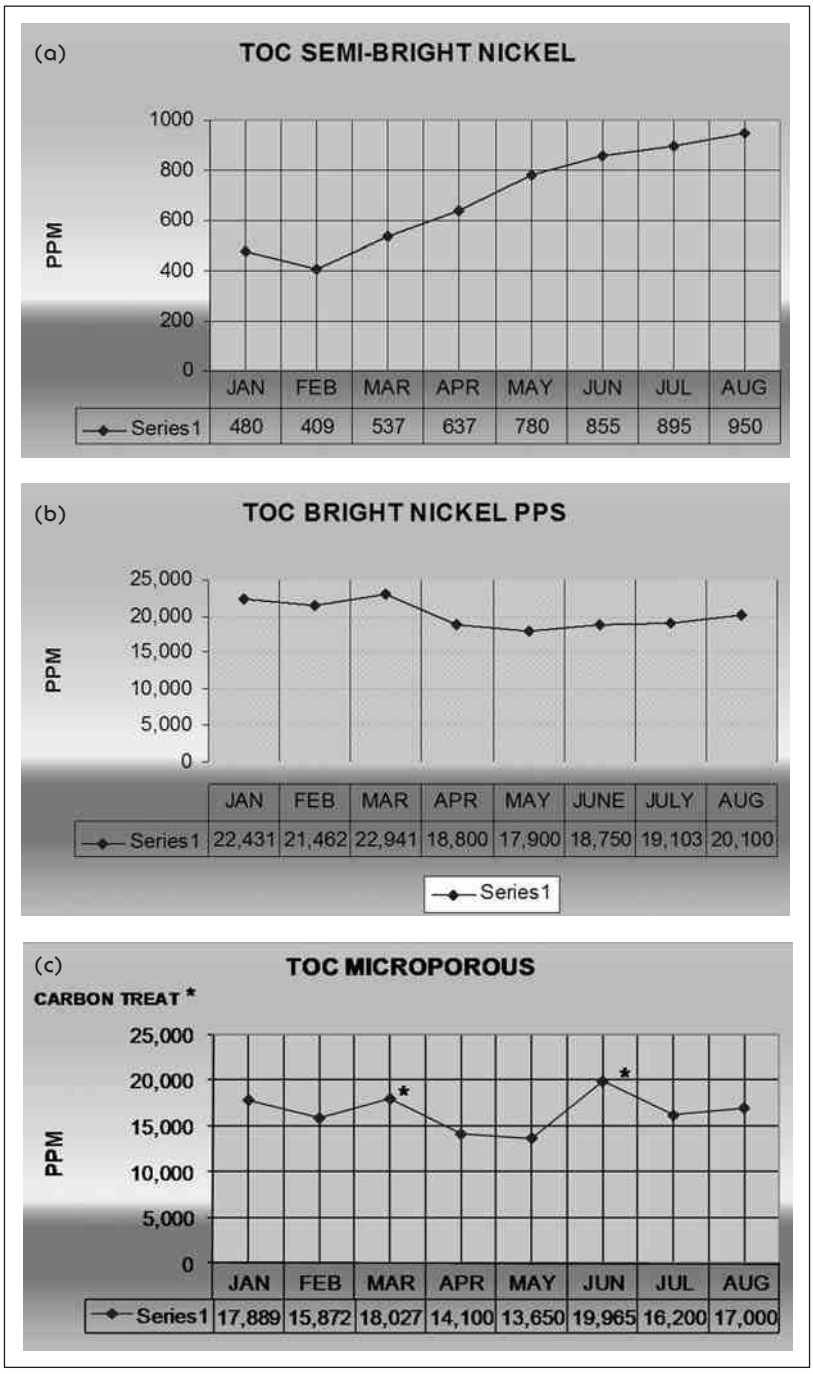
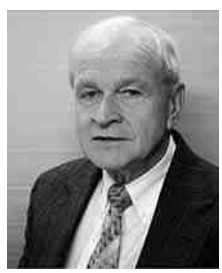


Figure 1—Tracking the TOC of a high volume, high quality nickel plating operation.
(a) Semi-bright SF nickel bath
(b) Bright nickel bath PPS
(c) Microporous nickel bath

The TOC analyzer, as shown in Fig. 2, is totally automatic, easy to maintain and the analysis is simple to perform. Depending on the concentration of material being tested, a sample is placed in a beaker as is or diluted. The program is set to go. The results are ready in five minutes with a direct reading and printed readout. TOC analysis is useful on any plating bath where organic additives are used. They are especially useful in checking the purity of water, both in rising and waste treatment. **P&SF**

Figure 2—Shimadzu 5050A TOC analyzer



About the Author

Ralph Dixon has been serving the metal finishing industry for the past 50 years in all phases, from technical field service to sales management with world class suppliers. He specializes in decorative nickel and chromium finishes to the appliance, automotive and motorcycle industries. He is currently involved as a consultant in the promotion of decorative plating processes in the United States, and South America with Basically Nickel Inc.