Dyeing Conversion Coatings

By MICHAEL MARZANO
Chemist
Pavco Inc.
Cleveland, Ohio

Soon after the advent of the metal surface finishing industry, finishers developed chemical processes to color the surface of a material. Colors ranged from silver white, patina, olive, and bronze to matte and glossy black, brown, blue, and even shades of red. The mechanism for dyeing parts has evolved into a manageable process that assures consistency and appearance quality.

Some of the most successful dye applications have been for anodized aluminum. Although a conversion coating is different than an oxide film, the same mechanism for applying dyes exists for zinc plating.

The main reasons for coloring zinc, and to a lesser extent cadmium parts, are aesthetics, identification and functionality.

Application basics. Dyes are adsorbed on and into the chromate conversion coating. The dye application must be done

TABLE I—Chromate + Dye = Color

Dye	Blue Bright	Yellow and Yellow Leach	Olive Drab
Red	Pink	Red	Maroon
Orange	Gold	Orange	Brown
Yellow	Yellow		
Green	Turquoise	Green	Dark Green
Blue	Blue	Blue	Dark Blue
Violet	Violet	Violet	
Black			Black

TABLE II—Dye Parameters

Dye Concentration	0.25 - 1 oz/gal[3] (1.9 - 7.5 g/liter)
Temperature	70 - 120F (21 - 50C)
Dye Immersion Time	15 - 60 sec
pH	4.0 - 6.0[4]

while the chromate is still wet, gelatinous and porous. If the chromate has dried, the dyeing operation will not be successful.

The chromate film thickness determines the color desired. Thus, clear chromates impart pastel colors, dichromates and their leached forms produce bright colors, and olive-drab-type chromates deliver solid, often deep colors.[1]

From the primary colors of red, blue and yellow, a whole rainbow of shades is possible. For example, a combination of seven parts orange dye and one part red dye produces a salmon-copper color over a blue-bright chromate.[2]

Table I lists the most commonly used dyes and corresponding colors obtained when used over given chromates. Table II lists typical recommended dye parameters.

Making adjustments. A typical dyeing cycle runs as follows: 1. plate; 2. rinse; 3. rinse; 4. chromate; 5. rinse; 6. rinse; 7. dye; 8. rinse; 9. rinse; 10. dry.

In barrel applications, many platers spin dry after the dyeing without rinsing. To avoid drying excess dye on the parts, at least one rinse is recommended after dyeing.

The importance of proper rinsing after chromating and dyeing cannot be stressed enough. Poor rinsing can cause contamination of the dye tank, non-uniform coloring, or even failure to adsorb dye. Tanks that are used to rinse chromated work should not be used to rinse dyed work.

There are blue dyes that are chromate stable and can be added directly to a blue-bright chromate. These dyes give a uniform blue chromate color and minimize or mask chromating imperfections caused by part configuration or long transfer times.

Unless the dye has been contaminated with chromium or the dye bath incorrectly made up, most problems in dyeing fall back on improper chromating or poor rinsing.

Some chromates adsorb dyes better than others. Platers may have to experiment with more than one chromate to find the one that works best for their application.

TABLE III—Troubleshooting Dye Operations

Problem	Cause	Solution
Dye does not take	pH too high or low	Adjust the pH down with acetic acid or up with ammonium hydroxide
Color too light	Low dye concentration	Add dye in 25 pct increments of the original recommendations
	Weak chromate concentration	Increase the chromating parameters
	Low chromate temperature	
	Chromate immersion time too short	
Color too dark or powdery	Strong dye concentration	Dilute dye in 10 pct increments until the problem disappears
	Chromate immersion time too long	
	High dye temperature	Reduce dye temperature
Color rubs off	Rinse before dyeing and/or the rinse after dyeing is contaminated and the pH is too low	Purge the rinse(s) until clear and the pH is > 5.0
	Dye is contaminated with chrome	Dump the dye tank
	Dye pH is too low	Adjust the pH with ammonium hydroxide
Color is powdery	Dryer is too hot and is dehydrating the chromate film.	Lower dryer temperature

Troubleshooting problems. Table III is a troubleshooting chart to help platers find and solve dyeing problems.

It is important for platers to be aware of health and safety considerations when handling dyes. Some dyes may be carcinogenic. Powdered dyes tend to be dusty and care should be taken when handling them. Check all MSDS and technical literature before using dyes to ensure that proper clothing, breathing equipment and tools are used. **PFD**

FOOTNOTES

1. There have also been chromates developed specifically for dyeing operations, which give extended salt spray resistance.

2. Platers should check with their dye suppliers for specific color applications.

3. A few dyes are so concentrated that the reconstituted makeup is 0.03-0.06 oz/gal (0.23—0.47 g/liter)

4. The pH is usually reduced with acetic acid and raised with ammonium hydroxide. Some chromates require the dye pH to be between 5 and 6.