SERFILCO

Achieving Quality Chrome Plating by Use of Agitation and Filtration

Producing high quality chrome plated parts takes diligent attention to detail. Many of the rejects generated with both hexavalent and trivalent chrome processes can be attributed to contamination introduced into the plating tank. We will show you well proven methods to lower reject and rework rates significantly by utilizing filtration and agitation techniques.

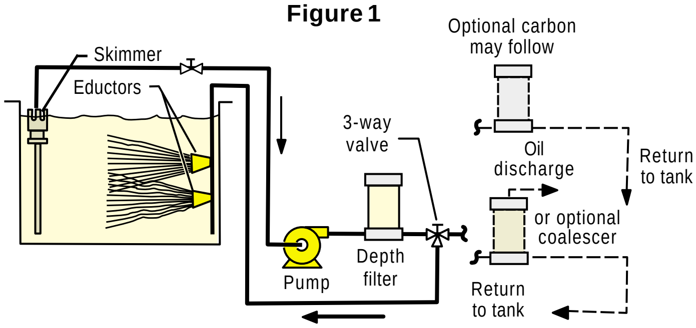
START AT THE BEGINNING

Our scrutiny of the process should always start at the beginning — the cleaning cycle. Scale, soils and oils were intended to be left in the cleaner tank while the parts progressed down the line. However, as soils and oils build to significant levels, they become part of the dragout and, like good little soldiers, march right down the line.

Once the contamination reaches the plating tank, the real trouble begins! The roughness and pitting from particulate and the poor adhesion from oils can best be attacked by keeping them out of the plating tank.

Recirculatory filtration on the cleaner will extend solution life, lower chemical usage and reduce loading on the plating tank filter. Adding a coalescer to remove floating oil from the cleaner rinse prevents the oil from even reaching the plating tank.

Figure 1



A typical sequence would be to agitate and high flow filter during working hours. At night, without agitation, liquid would pass through filter and optional coalescer at low flow to remove oils.

HEXAVALENT CHROME

Decorative chrome plating is normally deposited over nickel and/or copper. The base metal can be steel, cast iron, stainless steel or zinc diecast. Copper and nickel provide corrosion protection and leveling. Therefore, it is critical that good filtration be maintained on the copper and the nickel. 15 micron filtration on these baths with a separate carbon treatment chamber will maintain quality plating with no roughness, skips or pits.

Now we have produced a higher quality part and delivered it to the chrome tank. Since the operative word is 'Decorative', we want our efforts to result in lustrous, smooth, rich deposits which can only be described with one word — ***QUALITY.***

Hard chrome requires no predeposit of nickel or copper and nickel. Although cleaning may be done in a separate, alkaline process, the usual routine is to do a reverse current cleaning (anodic) in the plating tank. This creates higher dirt loads and can cast oils into the bath, promoting poor adhesion, roughness and pitting.

Both decorative and hard chrome rely on 'insoluble' or 'inert' anodes of lead or lead alloy. However, lead slowly reacts to form lead dichromate which precipitates. All of these sources form sludge which will slowly fill the bottom of the tank and settle on the work, causing pits and roughness. Secondarily, these residues will coat immersion heating and cooling coils and inhibit heat transfer.

A review of the literature on hexavalent chromium plating will reveal few recommendations on filtration. Many shops run without filtration until the sludge builds to a depth where plating is impossible. The solution is then decanted and the sludge shoveled out. This primitive approach works well until we attempt to improve the throwing power of the bath by adding agitation. When the bath becomes turbulent, the particulates in the sludge are resuspended in the solution causing those dreaded problems mentioned above.

PVDF and CPVC pumps and filters provide good lifetimes with these highly corrosive baths. Media of polypropylene, Hi-Perf and glass are available. All three media should be evaluated in each individual application so that the most economical workable choice can be utilized.

TRIVALENT CHROME

When plating trivalent chrome, we must think like a nickel plater. The approach of using two to three turnovers of the solution per hour with three 10" (25.4 cm) cartridges per 100 gallons (378 liters) of solution is the preferred method. The filter should be fitted with the carbon treatment option for control of organics.

Two forms of trivalent baths are commercially available. The sulfate bath uses isolated anodes of lead in a box with a semipermeable membrane to prevent oxidation to chromic acid at the anode. The chloride bath uses graphite anodes which sometimes slough off particles to the bath. The sulfate bath is purified by dummying. The chloride bath utilizes ion exchange or chemical purification to remove iron, zinc, copper and nickel. We recommend maximizing the surface area of filtration with chloride baths using chemical purification to accommodate slightly higher loadings from the anode slough and the precipitates from chemical purification.

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FILTRATION FOR QUALITY CHROME PLATING

We will now investigate the design considerations which lead to well engineered filtration systems. These considerations include proper media selection, turnover rates and filter system sizing. We can choose surface media, such as a paper or membrane filter or a depth media such as a wound cartridge. Each has its place. Surface media does well at removal of very fine particulate down to 0.1 micron where dirt loads are very low. Typical applications might include beverage packaging, fuel dispensing and final filtration of chemicals prior to use or packaging. But for chrome plating operations, depth filtration has proven to be the best choice.

Let's look at a depth wound cartridge to see how it does what it does. The passages of a depth cartridge are wide at the exterior and narrow through the windings to the pore size equal to the micron retention rating.

Since not all of the contamination in the tank is the same size, the frogs, birds and large fish are trapped in the outer pores. Since these large particles are unlikely to blind off the entire pore, smaller particles stick further in. The minnows and polliwogs are then trapped in the inner windings.

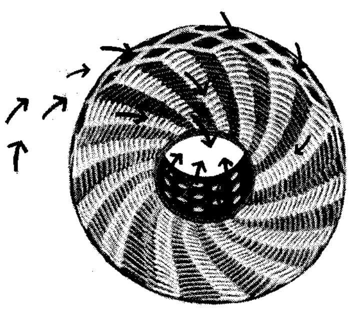


Figure 2
Typical pores of a depth wound cartridge

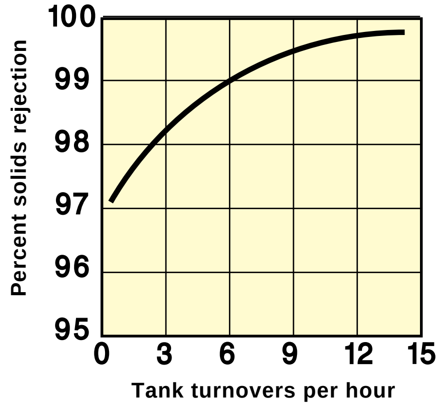
Cleaners require 50 to 75 micron. Hexavalent chrome will use 30 to 50 micron on most baths but some work may require 15. Trivalent chrome uses 1 to 5 micron. Copper and nickel are typically filtered to15 micron.

As the pores fill, smaller and smaller particles are trapped. Statistically with one 10 micron cartridge, 80 to 90% of the 10 micron particles are trapped in the first pass. Also, since the pores fill gradually, a significant number, say 30 to 50 percent, of the particles of less than 10 micron will be trapped.

Thus, successive passes serve to further reduce the particles. If a 10 micron cartridge removes 40% of 5 micron particles on each pass, the second turn leaves 36%, the third turn 22%, fourth turn 13% and by the fifth turn more than 92% of 5 micron particles will be removed! What has this taught us? High turnover rates remove sufficient amounts of particulates and will yield good quality plating. This is all accomplished with media that is economical and long lasting. Figure 3 shows the significance of turnover rate.

Cleaners require 1 or 2 turns per hour. Nickel and trivalent chrome require 2.5 turns minimum. Hexavalent chrome is 1.5 to 2 turns per hour.

EFFECT OF TURNOVER RATE ON SOLIDS REJECTION



Hydraulics indicate a turnover rate of 14 times is required to have all the liquid pass through the filter once.

Figure 3

We must also consider the sizing of the filter into the equation. The less time spent changing media, the better. Also, the lower the velocity of liquid through the filter, the more we increase dirt holding capacity. If the flow through a 20 micron filter is cut in half from say, 1 GPM (3.81 l/min) to 0.5 GPM (1.9 l/min), the dirt holding capacity increases by 40%.

What does this do for economy? Quadrupling the amount of media doubles dirt holding capacity of each 10" (25.4 cm) cartridge. However, now the time between cartridge changes will be 8 times longer. This will cut annual consumption of cartridges by 50%. Labor cost also takes a significant drop! Figure 5 illustrates:

ECONOMICS OF FILTER CHAMBER OVERSIZING

Oversizing Factor	Number of Cartridges in Chamber*	Dirt Holding Factors per Cartridge	Time Between Cartridge Change	Cartridge Consumption/ Cost Reduced by:	Labor Cost Downtime/ Solution Loss Reduced by:
1	C	D	T	0	0
2	2xC	1.4D	3T	29%	67%
3	3xC	1.7D	5T	42%	80%
4	4xC	2.0D	8T	50%	87½%

* Based on average sizing i.e. 1 x 10" (25 cm) cartridge per 50 gallons (200L)

Figure 5

Achieving Quality Chrome Plating by Use of Agitation and Filtration (cont'd)

To Summarize:

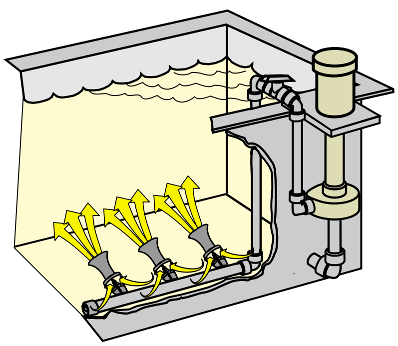
- Filters should have as much surface area as you can practically afford. The long term savings are immense.
- Use sufficient turnover on critical baths to keep particles at a consistently low level.
- Choose the proper media for both material of construction and micron retention. Depth cartridges are forgiving in that at even relatively high micron retention levels, small particles are removed.

AGITATION AS A QUALITY TOOL

Many platers today recognize the importance of bath agitation in chromium plating. Proper agitation eliminates temperature stratification providing more uniform thickness with no burning. While air agitation provides the vigorous agitation needed, this method has some major drawbacks. Among these are introduction of contaminants to the plating bath, higher costs and the environmental concern of misting or fume formation.

As an alternative, eductor agitation has proven to provide the needed agitation while eliminating the negative aspects of air agitation.

Figure 6
Tank Mixing Eductors



Tank Mixing Eductors have provided a new solution to these problems. The TME is a special designed thermoplastic device which, when placed in a tank at the discharge of a pump or filter system, will deliver 5 GPM (19.4 l/min) of flow for every 1 GPM (3.8 l/min) fed to it.

The following are some advantages of eductor agitation:

1. *Lower operating and equipment investment cost.*
2. *Eliminates heat loss due to increased evaporation caused by air agitation.*
3. *Eliminates contaminating vapors and particulates being introduced into the solution from the air compressor and blowers.*
4. *Improved mixing increases filtration efficiency by allowing less chance of particles settling out on anodes, work, heating or cooling coils or on the bottom of the tank where they can be stirred up later.*
5. *Reduces misting and fume formation that occurs in air agitation.*
6. *Agitation velocity will sweep gaseous products of electrolysis away from work, reducing pitting.*
7. *Eliminates temperature stratification without thermal impact on the system.*
8. *Air in certain baths will oxidize organic additives and produce undesirable oxidation of metallics.*

Conclusions:

- Filtration of cleaners and acid dip and subsequent oil removal **before** work reaches the plating tank improves quality dramatically.
- Depth filtration is the most efficient, economical choice for the chrome plating shop.
- The larger the surface area of the filter, the lower the operating cost of filtration.
- Use realistic turnover rates to minimize rejects.
- Utilize eductive tank mixers to save energy and improve quality.

We won't claim that these concepts alone will get you to ISO 9000 Certification or a Malcolm Baldridge Award, but you will have much more time and money to devote to the effort!