



Filtration and Plating Quality

Working backwards with filtration to eliminate barriers to high-quality plating.

Did we ever really have "quality" plating? In some cases we did. One can find examples of plated automotive brightwork and appliance or plumbing parts done in the 1950's and 1960's that still look good today.

Was the plating good because of heavy deposits and a lot of polishing and buffing? Was it due to proprietary solutions or laboratory technicians who sniffed and analyzed the process and were able to make it work right?

We also know about failed plating. Why did the shiny fenders on our bicycles, or the bathroom faucets, or those nuts, bolts or screws end up rusty? Were buyers who demanded low-priced products that looked good at fault? Could manufacturers "get by" by offering marginal quality because the price was right? Perhaps, but today's consumers are demanding higher and higher levels of quality.

How can high-quality plating be achieved? Better chemicals? Purer raw materials and anodes? Better proprietary additives? This certainly is a starting point.

Is a more uniform electrolyte or electroless solution the answer? Obviously so. Whatever the requirements, solutions must be maintained day after day, hour by hour, minute by minute. Statistical quality control dictates the need to know the conditions of the plating solution at the precise moment that plating will commence and know that an acceptable condition will be maintained during the entire time the part is in the tank. Platers need to know that the parts per million of insolubles (dirt particles) are being maintained at the lowest possible level to ensure quality results.

Those involved in highly sophisticated plating applications, such as computer memory disks, seek the ultimate in quality. They cannot tolerate co-deposition of solids or accumulation of organic impurities. All platers can benefit from understanding their techniques and dedication to "clean solutions."

Some have described various methods of filtration and carbon purification as "necessary evils." This certainly is not the case with today's improved equipment. Unattended filtration with minimum media changes is possible with very little solution loss or labor required.

Gone, for the most part, are layers of sludge, carbonates and super-saturated brighteners lying on the bottom of alkaline cyanide zinc tanks or murky solutions of copper, nickel, silver or cadmium. Instead, plating is and can be done in solutions often clean enough to call heads or tails on coins lying on the bottom of the tank.

Previous articles have stressed the importance of increased solids-holding capacity brought about by various grades of filter media, and the advantages of

increased flow rates in achieving fast particle removal from a plating tank. However, this article will stress the advantages of preventing particles from getting into the plating tank in the first place.

START WITH THE CLEANER. Special attention to the cleaning cycle is perhaps the best place to start. Even plastic parts that appear to be clean may have silicone mold release on their surface. Therefore, the proper cleaner with vigorous agitation in what was formerly a static tank, may be appropriate. Filtering the cleaner with an appropriate coarse media will maximize solids holding capacity and lengthen the cleaner's active service life. Should a layer of oil develop, it can be removed by decanting or skimming when the solution is not being agitated. Additional oil may be removed with coalescing media that will separate the non-dissolved oil from the aqueous cleaner. A prefilter may be required to keep the coalescing element free of solids.

Subsequent electrocleaning solutions followed by various rinses can also be clarified in this way with the addition of a chamber of carbon to adsorb oil. (Manufacturing process oils should never reach your plating solution.) As a final precaution, pre-rinses may require ion exchange to pick up soluble salts. Reverse osmosis may be required when troublesome salts might be present in recycled rinse water.

A skimmer on the pump at each tank in the pretreatment cycle will minimize carryover of surface contaminants to the next tank.

ANODES AND AIR. We now have probably prevented 50-60 pct of solids and other impurities from getting to your plating tank. What else can be done to prevent solution contamination? Quality of anodes, makeup water and chemicals should all be considered. Even the air that passes over the tank to an exhaust vent may be dropping solids. It is also possible that air used for agitation contains insoluble particles that can get into the tank. The air also might carry vapors from other process operations. These can be absorbed into the plating solution with the help of wetting agents.

"AIRLESS" AGITATION. Another method of agitating the plating solution uses high-flow centrifugal pumps that draw solution from the tank and re-deliver it through a sparger system similar to that used for air agitation. Educators strategically placed along the horizontal pipe direct plating solution across the bottom of a tank or up a cylinder or into difficult-to-plate, low-current-density areas. Each eductor creates, without additional horsepower, up to four times the actual pumped liquid being delivered to its orifice. This means instead of one gpm, you will be circulating four additional, or up to five gpm with the horsepower requirement of only one gpm.

This agitation method has a number of advantages, as follows:

- Elimination of vapors being introduced into the plating solution.
- Elimination of uncontrolled temperature changes.
- Elimination of air bubbles entering the suction lines of centrifugal pumps that could cause them to cavitate and lose prime.
- Minimizing brightener breakdown due to oxidation.
- Elimination of salt crystal formation in the holes of the dispersion piping.

With pumped/eductor agitation, we now are plating with a solution that is totally self-contained, where minimal solids or vapors can get into the solution and temperature is more easily controlled. We now can proceed to filter the solution to remove any particles that slipped by the barriers and add the necessary carbon to remove any brightener breakdown. However, the amount of carbon will be greatly reduced and less usable brightener will be adsorbed.

REDUCING FILTER MEDIA COST. There are steps you can take to reduce filter media consumption.

1. Prefilter as much as possible with preventive barriers as pointed out earlier, plus carbon adsorption if required in a separate chamber, then,
2. Use high flow rates with coarsest possible media to achieve maximum dirt-holding capacity. Example: three-micron instead of one-micron, or 30-micron instead of 15, but not 100-micron instead of one-micron. Increase filter media so that flow rate per cartridge or square foot is low, thus reducing velocity across the media. (Example: four cartridges instead of one will reduce media consumption by 55 pct). In other words, 12 cartridges instead of three with the same pump will consume 50 pct less filter media annually (Table below).
3. Use pump with eductors to minimize solids introduction to the bath.

CHOOSING A FILTER. The choice of a filter to achieve the final clarification will depend on a number of factors - how much carryover of particles occurs on the product to be plated, or what amount of insolubles are being introduced from tainted anodes, the atmosphere, chemicals or any other source.

Will the particles be slimy as in an alkaline zinc bath, which would blind off the flow through a surface filter

media? Or gritty and therefore easy to filter from an acid copper tank? Or contain precipitated iron from plating on steel in an acid zinc or nickel bath?

A quick evaluation will at least help you get started in the right direction. Choose 15 to 75-micron retention for the slimy zinc or precipitated iron, and denser on most other baths. Depth-type filter media provides for this range of particle retention. Otherwise, if surface media is employed, then an extended area must be considered to match the solids-holding capacity to maintain good flow rates.

Note that flow rates across the media will somewhat change the percentage or efficiency of retention because of the different levels of velocity per square foot of surface or per cartridge. It is worth considering increasing the amount of filter media so as to reduce velocity. Remember, reduced velocity across the filter media will pay big dividends by reducing the actual amount of cartridges expended or frequency of surface cleaning.

Extending the life of filter media requires matching particle retention ability of the media to the range of

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solids present in the liquid. Unfortunately, we usually don't know the percentage of particles of each size so we must rely on past experience. If necessary, coarser or denser media can be substituted to achieve the desired results.

Having sufficient solids capacity is the main requirement of a filter, so that the pressure drop across the media is minimal over the time between servicing. This is one factor in favor of depth-type cartridges, because psi drop is usually low over 85 pct of their life, whereas surface media follows a straight line increase in pressure drop.

When pressure increases across the media, flow decreases (based on the assumption that virtually all pumps used with plating solution filters are centrifugal). A reduction in flow is critical to the ability of the filter to remove particles from the plating tank, because we are using recirculatory filtration on a reservoir (the plating tank) instead of in-line clarification, as might be the case of a filter on your incoming water line.

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	0	D	T	0	0
2	2 x 0	1.4D	3T	29 pct	67 pct
3	3 x 0	1.7D	5T	42 pct	80 pct
4	4 x 0	2D	8T	50 pct	87½ pct

Recirculation has other benefits. Suppose a certain type of filter media stops most of the solids you want to retain, but not all. Thereafter, a second, third, or fourth pass through the filter may produce the desired result.

For instance, if a filter media having an efficiency of 90 pct retention of five-micron particles is used, it also is removing some lower percentage of finer particles, let's say 50 pct of three-micron particles. If the porosity of the

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media didn't change you could expect to pick-up an additional 50 pct of the three-micron particles on the second pass, now leaving 25 pct of what you started with. With constant recirculation, it is possible that essentially all three-micron particles could be retained in the media. But it must be pointed out that this clarification only applies to the solution that passes through the filter, which is why turnover rates are so important.

There is, of course, the effect of increased density caused by the collected particles on the media, which may speed up or increase the percentage of retention. Or their presence may hinder the flow and slow down the turnover rates. This would suggest that too-dense media may have been used.

Filter media with a broad range of porosities lends itself to recirculation applications. Consider the possibility of using coarse media instead of fine or two grades of media on the same tank.

A significant benefit of using less dense media to achieve the desired particle retention is the increased solids-holding capacity offered by coarser media. Compared with fine media, coarse media may provide up to five times the solids retention before flow is reduced to an unacceptable rate. The media is then replaced with coarse media and recirculation commences until all of the liquid is clarified.

Will it work? Yes, it has worked for years. Swimming pools, hydraulic and lubricating systems, plating and other types of finishing processes usually don't have a "dirty" tank and "clean" tank. They rely on continuous recirculation filtration to get the desired results. The difference is that these applications allow for some solids to be present in a limited amount until removed. This presence of solids could not be tolerated in the finished product such as beer, whiskey, soft drinks, food oils and syrups or chemicals, hence the need to either do a good job of filtering the first time, or recirculate until the desired clarity is achieved. We are aware of many examples of success with coarse media. For instance, 30-micron cartridges will keep hydraulic oil looking like new, will change a neglected swimming pool from green to clear overnight and turn a slimy-oily alkaline zinc solution from milky to clear. It all depends on the number of passes, which dictates the flow rate required.

For instance, a 1,000-gal. batch being transferred at 10 gpm will take one hour and forty minutes, but to turn the tank over ten times to achieve 100 pct contact with the filter, a 160 gpm pump is required. With one-hour turn-over recirculation a "dirty" tank becomes clean with the solids in the filter and the desired results are achieved.

Now let us take this approach one step further, keeping in mind that high quality plating is your number-one objective. Ten turnovers per hour might come close to having all of the solution pass through the filter at least once. But you're plating every time parts enter your solutions. Do you need ten times turnover per minute? Probably not, but the fact is your original intent was to filter out the particles to achieve high-quality plating. Remember, in the name of Malcolm Baldrige or ISO 9000, no rejects. So, you do have to consider the turnover rate that will achieve your objective.

If organics are a problem due to their decomposition, then separate carbon treatment is required. Some platers still use powdered carbon, citing a need for fast adsorption of organic impurities either in a batch process or with the carbon coated on the surface of the filter. However, if uniform purification is necessary, gradual, consistent adsorption downstream of the filter works very well, offering some significant advantages that contribute to solution clarification and desired levels of plating quality.

A separate carbon chamber allows the filter to achieve maximum solids holding capacity and maintains a low level of organic impurities without the mess of handling

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the dusty, black powder. Other benefits include a reduction on manual evaluations in the laboratory and, when troubleshooting is required, it is comforting to know that bath contaminants are not the cause.

Statistical quality control will monitor results attainable from increased filtration and separate carbon purification, or indicate the further need to increase same until the ultimate quality goals are achieved.

Some platers may still be using powdered carbon to adsorb organic impurities. Standard practice was to insert a filter aid that would precoat the surface of the filter media, making it possible to support or retain a mixture of powdered carbon and filter aid. This practice required frequent filter servicing because the powdered carbon restricted the flow, reducing the amount of solids that could be retained by the filter before service was necessary.

Platers considered using granular carbon because it didn't reduce the flow rate as much, although the rate of adsorbency was considered to be less because solids could plug the pores at the surface of the granule. It wasn't until platers switched the sequence and filtered first and then allowed the solution to pass through the unrestricted pores in the granular carbon, that equivalent adsorption was achieved.

... look for ways to prevent solids and oils from getting to the plating tank in the first place.

In conclusion, I'd like to remind you to work backwards through your processing sequence to create a filtration program that will give you clean solutions and high-quality deposits. Start with the pre-plate cleaning and rinsing steps and look for ways to prevent solids and oils from getting to the plating tank in the first place. Move forward to the plating solutions, recognizing the effect flow rate (turnover) will have on getting the solids to the filter. Consider the benefits of two-stage, coarse filter media for the extra solids-holding capacity it can provide. Consider

"airless" solution agitation. When the program is established and operating smoothly, you will notice a reduction in laboratory personnel becoming involved in problem solving. Instead, they will have more time to work on other aspects of your total quality assurance program.

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Reprinted from
PRODUCTS FINISHING
November 1993

Edited December, 1997



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