

The need for greater cleanliness in the deposition of high-quality finishes has brought about an evolution in the filtration of plating solutions. Many platers may still recall the occasional batch transfer of a plating solution from one tank to another through a filter. The plater usually employed some type of filter aid which prolonged the life of the filter membrane. By creating a porous cake for the liquid to pass through and strain out the undesirable solids, small particles which could have caused shelf roughness were removed from the plating solution.

## PRECOAT FILTERS

However, platers soon found it necessary to filter their solutions continuously because roughness occurred every time any particles that had settled to the bottom of the tank were stirred up. By efficient, continuous filtration, most particles were removed before they had a chance to cause problems.

While precoat filters can provide for very fine particle removal, they are subject to certain shortcomings, as platers discovered. The precoat material, which is supported by the membrane, is subject to migrating or sloughing-off should any drop in differential pressure occur across the filter media. Also, the dirt-holding capacity is limited because the precoat material produces a very dense medium through which the liquid must pass. As the small pores are plugged with dirt particles, the flow is gradually reduced until it stops completely. The filter cake must then be removed and replaced. This requires a certain amount of know-how and experience - not to mention lost time and expense.

In order to have a reasonable amount of time before it became necessary to clean the filter, platers oversized the filter to provide sufficient dirt-holding capacity. In practice, servicing would then be required anywhere from a few days up to several weeks, unless unusual oversizing was provided.

## VERSATILITY OF FILTER CARTRIDGES

Platers then sought other means to lengthen the time cycle between filter cleaning. They determined that, with coarser filter media, the flow rate through a given area is higher and the dirt-holding capacity is increased.

Various types of filter media are available, but the fiber-type wound cartridge offers the greatest flexibility in porosity (1 to 100p). Thus, the optimum porosity in relation to the size and number of particles to be removed can be selected to achieve longer operating periods and less servicing of the filter.

Because of their depth, cartridges increase the effec-

tive filter surface five-to-seven times compared to a flat membrane with filter aid. They are available in cotton, polypropylene, rayon, glass and other fibers for a variety of applications. The polypropylene cartridges are suitable for most plating baths. It is recommended that they first be flushed with warm water to remove residual lubricant. To facilitate cartridge changing, they can be obtained in 10", 20", 30" or 40" lengths to fit various size chambers. Precision-wound, cartridge-type filters also offer the advantage of dry disposal with little solution loss and, overall, a clean and simple method of operation with maximum economy.

## IMPORTANCE OF FLOW RATE

Initially, 25 - 30 years ago, the cartridges selected were capable of 3 - 1  $\mu$  particle retention, because it was felt these particles caused roughness. Experimentation later showed that slightly coarser; 15 $\mu$  cartridges could be employed with equal success. The flow rate across the filter increased because the filter media was coarser and less restrictive.

Today, many platers have found that by increasing their pumping rates from less than one tank turnover per hour to three or more turnovers per hour, they can use filter media as coarse as 30 to 50 $\mu$ . At the same time, the net pressure drop is reduced by about 50% and a substantially higher flow rate through the filter is achieved with the same pump. The increase in cartridge porosity also increases the dirt-holding capacity before the filter needs to be serviced; on certain alkaline solutions which have slimy contaminants, filter media as coarse as 75-100  $\mu$  are now used successfully for weeks at a time.

In order to achieve long intervals between filter servicing, it is necessary to employ a filter media as coarse as possible; but this alone will not do the job. Flow rates at sufficiently high tank turnovers are required to make coarse filtration work. This same high flow rate creates the velocity necessary to carry particles off the bottom of the tank and into the filter, in much the same way as some swimming pool operators use vigorous agitation in order to avoid costly manual vacuuming to clean pool bottoms.

## AGITATION

Remember, when working with small still tanks, you may have what appears to be a high flow rate, such as 3-times per hour turnover rate, or 100 GPH on a 30 gallon tank. However, a flow rate of 1.6 GPM will not create sufficient velocity to lift even small particles off the bottom of the tank. This is why platers who are trying to meet the highest plating standards must employ flow rates much higher than what otherwise might seem to be adequate. Agitation

rates are evolving to 20 turnovers per hour and, in the case of pumping and filtering for electronic use, turnovers of 20 to 50 times per hour are not unusual. Ser-Ducting makes this level of agitation possible and practical.

## ADVANTAGES OF COARSE FILTER CARTRIDGES

Earlier, it was noted that particles in the 3-10  $\mu$  range can cause roughness. How then, can a 50, 75 or even 100 $\mu$  cartridge achieve the clarity required to maintain quality plating? It should be pointed out that coarse cartridges are not limited to the removal of large particles only. As the outer cartridge surface becomes loaded with particles, the openings grow smaller and smaller. More and more of the smaller particles are retained by this gradually forming "pre-coat".

Cartridges are rated according to their ability to remove a minimum of 90% of the particles contained in a test sample of either fine (FAAD) or coarse (CAAD) Arizona-air dust to meet a given micron rating. While a 50 $\mu$  cartridge will remove 95% of 7.5 $\mu$  particles, it is also capable of removing 50% of smaller particles, and even 5% of 5 $\mu$  particles.

As an example, if you attempt to filter dirty river water through a filter with a 75 $\mu$  ~ cartridge, you will see little evidence that much is accomplished on a single pass through the filter. But, on each succeeding pass through the filter, a very small percentage of fine particles are removed. As the filter cartridge picks up these finer particles along with coarse particles, the cartridge itself becomes denser and the percent of finer particles removed on a single pass through the filter is increased until, finally, virtually all of the particles are retained on the filter.

Obviously, when a plater circulates solution in a still tank in which a lot of solids have settled and pumps them through a coarse filter, he cannot immediately produce high quality work. The solution must be recirculated through the filter a number of times before quality plating can be performed.

Filtration of plating solutions with filter cartridges as media has had some other beneficial effects. Solution losses, as pointed out earlier, are minimal because the cartridges can

be flushed with water and returned to the bath. Seal life in the pumps is greatly improved because filter aid, which is abrasive, is no longer employed. When seal life of the pump is improved, losses of solutions due to leakage are prevented. Also, priming problems are minimized because, if a seal is tight, it does not allow air to be sucked into the pump to cause cavitation and make pump priming difficult.

## CARBON PURIFICATION

No discussion on filtration of a plating solution is complete without consideration of the use of activated carbon for adsorption of undesirable organic impurities. Years ago it was thought only the finest powdered carbon had the ability to achieve the purification required. This was usually done by a batch treatment with powdered carbon, which quickly adsorbs impurities upon contact. The powdered carbon was mixed with the solution in a special tank and, after several hours of agitation, the solution was filtered through a pre-coated surface to remove all carbon. With sufficient carbon, all of the organics in the solution were removed.

As time went on, it was found that by putting a small quantity of carbon into the filter while recirculating a plating solution, a certain degree of purity could be achieved or a tolerable level of impurity could be maintained for quality plating. At the same time, not all of the desirable organics such as brighteners and wetting agents were removed from the solution. This pre-coating of powdered carbon onto a pre-coated surface filter was sometimes followed with a second step of pre-coated filter aid on top of the carbon to achieve slightly longer service life between filter cleaning. In general, whenever powdered carbon was used with a filter, shorter operating periods were experienced, since the carbon particles quickly loaded up the filter surface just like small dirt particles.

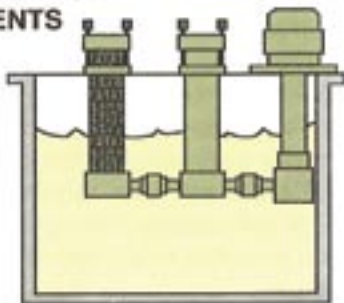
## GRANULAR CARBON

Granular carbon, which is easier to handle than fine powdered carbon, was tried in batch processes with very little success because adsorption was too slow or inefficient - nothing forced the liquid through the pores of the granular carbon. If granular carbon was used with a pre-coat in the

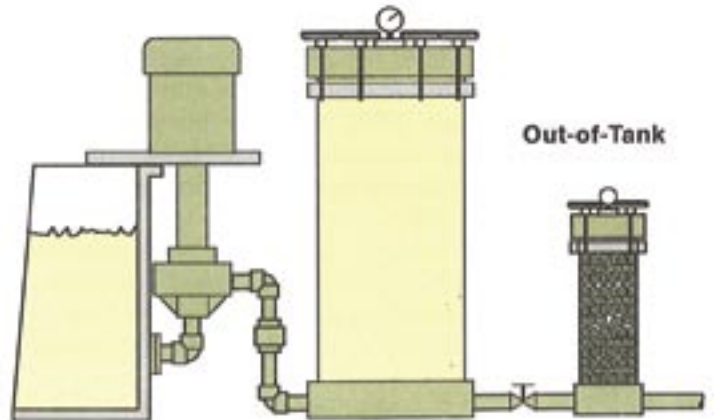
### TYPICAL INSTALLATION ARRANGEMENTS

Fig. 1

In-Tank



Out-of-Tank



filter, the pores quickly became plugged with dirt or blinded over so that, again, little purification was achieved. The only way granular carbon could be used effectively was in a separate chamber in which clean liquid was forced through the porous carbon granules (see Fig. 1).

This was achieved if the solution was filtered first, so that only the clean solution contacted the granular carbon in a second chamber. A small filter cartridge was then added to the chamber to serve as a final trap (Fig. 2) to prevent any fine particles of carbon from going downstream back into the plating tank.

The separate, continuous purification process offers several advantages to the plater. He can control the amount and rate of flow through the granular carbon to achieve optimum adsorption of impurities without complete depletion of brighteners and wetting agents. It provides for uninterrupted production and fewer rejects due to excessive contamination. More platers are finding it unnecessary to resort to the messy and time-consuming batch carbon treatment. However, both the filter and the carbon chamber must be properly sized to obtain consistently bright, smooth deposits. A larger system, although slightly more expensive, soon pays for itself in less service and maintenance labor. It also provides more efficient dirt removal and better agitation.

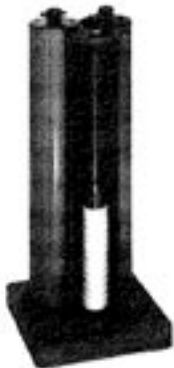


Fig. 2  
Trap filter arrangement for chamber

## POLLUTION CONTROL; CARBON TREATMENT

Carbon treatment has become increasingly important during the last several years. In the past, many platers relied to some extent on high drag-out rates to control contamination. Although effective, it proved to be very costly to platers due to great increases in the cost of chemicals. Now, platers are faced with stringent regulations for pollution control and must re-examine their filtering and carbon-treating practices.

Countercurrent rinsing with proper and regulated flow of rinse water represents a major technical advance in reducing water usage. Effluent regulations have forced many platers to install reverse osmosis, ion exchange or distillation units to clean up rinse water for recycling. In most of these processes, organic impurities are not removed and they gradually increase in concentration in the plating tank. If contamination is allowed to build up, plating rejects result. A batch carbon treatment is then required, which means loss of production time.

Continuous carbon treatment best controls organic contaminants and prevents their excessive build-up in the plating solution. This treatment should be started with a new purified bath when the recycling process is put into production. The preferred method is to pack the carbon chamber or canister with granular carbon. The purification chamber is installed

downstream from the filter chamber with a bypass arrangement so the carbon receives only clean solution. With the bypass arrangement, flow can be controlled through the carbon to minimize brightener loss and, at the same time, optimize purification of the solution.

Carbon should be replaced every few weeks on a cycle that can only be established by production experience and Hull cell test. Following this practice, the necessity for batch treatment can be avoided.

## SYSTEM SIZING

Relatively high rates of solution turnover are recommended in this article. This recommendation will seem very logical when you plan for filtration and carbon treatment, especially in conjunction with countercurrent rinsing and recovery systems.

Today's filtration-purification systems employ relatively coarse filter media such as those available with cartridges. The service period between filter cleaning and cartridge replacement is often two-to-six months, and sometimes even longer if the dirt load is light or the filter is oversized. The carbon is replaced periodically in the canister, or chamber,

which should be large enough so carbon replacement is not required more than once or twice a month. With a bypass valve, which isolates the carbon chamber, the changing of carbon does not disrupt the filter and plating operation.



Fig. 3  
Pump with water-flushed mechanical seal.

## PUMP & MOTOR SELECTION

Filter systems are available for in-tank installation or for use away from the tank. If the pump is installed in the tank, leakage and seal problems are minimized, but adequate space must be available so the pump and filter are

not in the way of the plater. It is important that pump and motor are adequately sized to provide the desired pressure and flow rate.

Most shops use out-of-tank installations because of space limitations. Seal-less magnetic pumps are used frequently to avoid leak and seal problems. With horizontal centrifugal pumps, protection from leakage can be achieved with water-flushed, double mechanical seals (Fig. 3). This prevents crystals and other abrasive particles from collecting in the seal and causing premature seal wear. If the seal does leak, the solution can be collected or directed back to the plating tank along with the small amount of

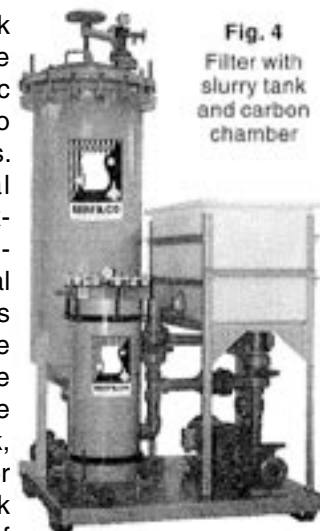


Fig. 4  
Filter with slurry tank and carbon chamber

water (usually less than a few gallons per hour) used for flushing the seal. Out-of-tank filters may have a slurry tank located over the pump to make pump priming easier. This also allows for liquid chemical additions which must pass through the filter before entering the plating solution. The slurry tank can be valved for acid backwashing cartridges to prolong their life (Fig. 4).

## FILTRATION TIPS

All hoses and pipes to and from the filter must be properly sized and fastened so they don't slip out of the tank. Care must be taken to avoid tight bends, which could easily collapse the hose on the suction side of the pump or cause a hose to pull from the adapter on the pressure side of the filter. Large-enough hose should be employed on the suction side to prevent solution flow restriction and pump cavitation. Only solvent sealed pipe joints offer maximum protection against solution losses even when threaded connections are used. "O"-rings in the joints also give added protection against solution loss.

Care in selecting construction materials for any filter system must be exercised. Plastics such as CPVC or PVDF with high temperature / corrosion resistance are suitable for all plating baths and not subject to electrolytic action caused by stray currents.

## PROPER PRETREATMENT

Even the cleanest and best plating bath cannot produce adherent, uniform deposits on dirty or contaminated work surfaces. Many plating problems originate in one of the cleaning or pickle tanks. Check all cleaners periodically to make sure they are operating at specified strength and temperature. Any floating soil or oil must be skimmed or it will be dragged into the plating tank. Dirt and solids should be allowed to settle over a weekend and the tank cleaned as often as necessary.

Filtration of acid pickle tanks has proven beneficial on decorative plating lines. The removal of dirt and scale particles increases the life of the pickle solution. Rinse tanks should be inspected every day and checked for water flow and clarity. A conductivity monitor will pay for itself by savings in rinse water usage.

## SLUDGE FILTRATION

Automatic gravity filters (Fig. 5) are used on phosphating tanks to remove sludge generated in the process. The solids are collected from a pool on a disposable fabric stretched over a horizontal conveyor belt. Fresh fabric automatically indexes as needed to provide uninterrupted filtration. The sludge and media are collected in a tote box for dry disposal, while the filtrate is returned to the process tank. The filter is also effective in filtering metal hydroxide effluent after precipitation and settling to reduce the suspended solids for sewer discharge. Various media and porosities are available to meet different applications and requirements.



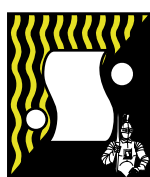
Fig. 5  
Disposable fabric "gravity" filter

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## FILTRATION HIGHLIGHTS

Plating quality can be improved by removing as many particles and contaminants from the bath as possible; continuous filtration and purification offers the best means of accomplishing this. Depth-type cartridges are efficient filter media, with maximum flexibility in porosity and fiber selection. With recirculatory filtration, coarser cartridges are preferred to provide higher flow and dirt-holding capacity. Separate carbon chambers are recommended for purification in order to control the treatment at the optimum level required.

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