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SERFILCO®

FILTERS: THE BEST SOLUTION

The cost of adequate filtration is negligible compared to the value of quality work that passes through a properly filtered solution.

Basic facts

Plating requires many critical process steps involving either solvent or water solutions that become contaminated with soluble and insoluble impurities. These impurities must be removed to maintain acceptable quality standards for finished parts. For liquids, the most efficient method of particle removal is by means of wound depth tubes, which offer the widest choice of fiber materials with porosities from 1 - 100μ (1μ = 1 micron = $4x10^{-5}$ inches = 40μ in.) to meet all filtration requirements. With a capacity of one cartridge per 50 gal. (189.5 L) and flow rate of at least two tank turnovers per hour, particles are continuously separated before they can cause rejects.

Dirt load, size and kind of suspended solids must be considered in the selection of proper cartridge porosity, which should be as coarse as possible for maximum dirt holding and flow, but dense enough to achieve the high degree of clarity required.

Organic and inorganic contaminants are best removed by adsorption with activated carbon in a separate chamber. To prevent surface loading of carbon, carbon adsorption should be done after filtration.

The purification system must be sized sufficiently large to minimize maintenance. Pump selection must take into consideration location, head and flow requirements, corrosion and temperature conditions. All components are assembled into a functional package with valves and other accessories for maximum efficiency.

The electronics industry uses many liquids in the various processes required to manufacture printed circuit boards or other electronic components. Quality water is most essential because it is used for solution makeup, rinsing and cooling. Various water treatments may be required, including softening, deionizing and/or purifying with carbon. All of these may employ prefiltration for solids removal to prevent surface loading of the resin or carbon. This may be followed by several stages of trap filtration down to and including sub-micron sizes if absolute clarity is required.

All of the electroplating solutions — such as copper, tin-lead solder, tin-nickel and nickel, the precious metal baths — such as gold and rhodium, plus all of the electroless plating solutions — such as nickel or copper, require filtration for removal of solids. Some of these solutions require activated carbon to remove organic impurities; carbon purification is sometimes handled with filtration equipment.

The need for filtration/purification of plating baths in the manufacture of printed circuits cannot be overemphasized, especially where copper is used for through-hole plating to achieve continuity through each hole to facilitate soldering and assembling of components. Any void in the plating in the hole caused by contaminants reduces the area available to carry electric current. A complete void would totally prevent contact with the hole. Rejects would also be caused when tin-lead or tin-nickel are used as a resist in the etching process because any voids would allow etching in unwanted areas. Nickel, gold and rhodium plating baths may or may not be as critical, depending upon the requirement of a finished product. Contaminants in any of these solutions would result in a rough plate on circuits or connector tabs.

As recently as 20 years ago filtration was looked upon as a necessary evil. The basic problems were these: filters required frequent cleaning; leakage from pumps was a common problem; the materials of construction were limited, often expensive, requiring complicated assemblies.

Modern Filtering

Today, filter cleaning is less frequent; some filters run two to four months without cleaning. Leakage is a thing of the past. Materials of construction are available that resist the attacks of all plating solutions.

What happened in those intervening years? A developing technology has been applied to the problem of proper filtration for the plating industry. New materials of construction have led to better pumps and filters.

Let's explore how these major problems have been solved. First, what makes a filter run longer? Obviously, it's less drag-in from better cleaning, or more dirt-holding capacity, brought about by new methods of holding the dirt in the filter. Perhaps the most significant change in filtration in recent years is the use of depth filter cartridges to distribute the dirt below the surface.

Just as important, however, is the use of depth cartridges that are coarser and can achieve the same

Editors note: Quality finishing cannot be accomplished with dirty solutions. Efficient filtering must be incorporated into good finishing practices, no matter what type of finishing is being done. In this article, internationally famous filter and pump expert, Jack H. Berg, reviews filtering as it applies to the various plating baths. The principles, however, relate to practically all solution filtering, be it plating, painting or cleaning. The marketplace for filters and accessories is broad and offers each finisher more than one solution to his filtering problem.

degree of solution clarity as denser media, but do it cheaper. This is achieved through the use of high flow rates to constantly circulate the plating solution through the filter, over and over, until the desired clarity is achieved and maintained.

Second, the problem of leakage has virtually been eliminated through the use of several new pump designs: Magnetic coupled pumps; in-tank seal-less pumps; out-of-tank horizontal centrifugal pumps with double, water flushed, mechanical seals. This design uses two seals in the pump with 2.1 gal. (8L) per hour of water running between them. This eliminates the formation of salt crystals on the seal faces, which would otherwise cause abrasive wear, and it thus prevents the pump from sucking air or being difficult to prime. The leakage problem has been reduced through the use of "O" ring seals, which are installed as a back-up on all screwed fittings.

Third, non-metallic materials of construction for pumps make them resistant to chemical attack and eliminate corrosion from stray currents. Many pumps and filters are made with CPVC, which withstands 212°F (100°C) and is used regularly on chrome, acid copper, hot electroless nickel, all standard nickel, even the new non-cyanide chloride solutions and highly alkaline solutions.

Complete PVDF filtration systems are also available and recommended for high purity applications like semiconductor and memory disc manufacturing.

Other developments and application of equipment have also helped the plating industry. One major development is the use of a separate carbon chamber for removal of organics, making it possible to use the coarser filter media to achieve maximum solids reduction. Thus, placing the carbon chamber downstream from the filter feeds only clean solution to the carbon, prolonging carbon life. Because the carbon is in a separate chamber, it can be changed as necessary without changing the filter, which usually does not require changing at the same time.

Sizing the Filter

Technological developments, however, are of no value unless the equipment available to the user is properly applied. Of particular importance is sizing the filter and selecting the right pump. This means that the filter media must be dense enough to remove undesirable impurities at a flow rate high enough to have all of the plating solution pass through the filter at sufficient intervals so that the solids will be trapped. It follows from this that the filter must have a high enough solids holding capacity to maintain flow rate.

Unfortunately, in practice these requirements are not always met. The average plating solution is probably turned over at the rate of once per hour, which is half the desired turnover rate. To achieve the ultimate in clarity, turnovers of up to 10 times per hour might be required, but this decision has to take into account the requirement of the application.

Flow Rates

Flow rate is the only means of carrying solids to a filter or bringing fresh solution into contact with carbon. The rate of flow is referred to as turnover - total volume pumped per unit time in relation to the size of the tank. A pumping rate of 200 gph on 100-gal (758L/hr on a 379-L tank) is two turnovers/ hour. Dirt holding capacity is essential and can be attained with throw-away wound cartridges of different porosities or filter surfaces coated with filter aid; porosities of 100μ (4000μin.) are typical.

If flow rate means average, then it is not the initial flow rate. For example, if the initial flow rate is 1055 gal. (4000L) per hour and the flow rate drops through usage to 211 gal. (800L) per hour before the filter is cleaned or replaced, then the average flow rate is about 633 gal. (2400L) per hour, depending on the type of filter media used. When sizing for flow rate, one should consider the average flow rate.

The importance of sufficient flow rate cannot be overemphasized. One will never reach the point where the increasing density and decreasing flow rate will be acceptable, because plating bath solutions are never 100% free of solids at all times, even though they may be free of certain size particles. The better the dirt removal, the longer the plating bath can be operated before a general cleanup with batch filtration must be employed. In practice, contaminants are not introduced at a steady rate. Some contaminants are introduced with the parts to be plated, and contamination is thus immediately increased when the part is immersed. Filtration reduces this, but contamination increases again when more parts enter the bath.

If the plater could keep an accurate reject count he could watch rejects increase to a point at which he would dump the bath or batch. He could filter and transfer it to another tank, then filter the solution on its return to the plating tank. The amount of clarity he would obtain would depend on the porosity of the media selected. Based on these considerations, the plater could check his percent of solids, compare it to previous data and estimate the percentage of rejects he could expect. The same considerations could be applied to solutions used in applications other than plating.

Depth-type filters

One common type of filter media used in the plating industry is the depth-type filter cartridge, which is available in different porosities/densities to achieve particle retention from 4000 to 20 μin. (100 to 0.5μ) on a nominal basis. Depth cartridges are wound from cotton, polypropylene or other synthetic fibers to achieve compatibility with the chemicals in the plating solution.

The fibers are wound to form a surface of diamond-shaped openings. Each succeeding layer of fibers lock fibers of the preceding layer in place. As layers are built up, the circumference of the cartridge increases, causing the diamond-shaped openings to become larger and larger. The flow of liquid being filtered goes from the outside to the inner core; the larger particles are removed first, and each succeeding layer, with smaller openings, traps succeedingly smaller particles, according to the porosity of the particular cartridge. In other words, the deeper into the filter, the finer the filtration; hence the term depth filtration.

Cartridges measuring 2.46 in. (6.25 cm) in diameter by 9.85 in. (25 cm) in length can hold more solids than 3.5 sq. ft. (0.325 sq. meters) of surface area, depending on sizing of the dispersed solids. Sometimes additional use may be obtained by soaking in acid. Depth-type cartridge filters offer the same fine particle retention as some filter aids, but are also offered in very coarse porosities - as high as 4000 µin. (100µm). This flexibility of the depth cartridge is why it is so popular. The user has the option to select coarse cartridges when increased solids holding capacity is required, or finer cartridges.

Remember the basic considerations mentioned earlier: select the filter media, whether wound cartridge or precoat, with the density required to give the combination of solids-holding capacity and flow rate to turn the tank over according to the frequency required. It is impossible to give a single rule for every instance. Each case is different and involves a set of calculations based on the size of the tank, the size of the pump needed to maintain the flow rate, the type of media and its porosity, the turnover, the type of plating solution that will affect the solids to be filtered out and other such considerations. But it is clear that selecting filter media should be done with as much care as exercised in selecting plating chemicals.

Carbon filtration

It is possible that batch treatment may become necessary because of the buildup of organics; bypass or sidestream carbon purification can prevent this buildup. A safe level of solution clarity can be maintained at a reasonable cost with this method. All that is needed is a bypass chamber sized to provide a flow rate high enough to bring the contaminated solution into contact with the carbon. This is much more economical than providing full batch carbon treatment.

There are other benefits too. Sidestream or bypass purification is preferred to precoating the filter with filter aid and carbon, because the carbon in a filter increases the pressure differential across the filter and thus reduces the flow rate. In addition, carbon on a filter reduces the amount of contaminants that the filter can retain prior to servicing. The reduction in flow rate means that the solids or organics will not be removed from the tank as efficiently.

Effects of pressure

Specifying a pump with enough pressure is important. The pump should be capable of providing enough pressure to maintain the desired flow rates at all times, even as the filter media becomes progressively clogged. A pump often is recommended to maintain 28 psi (195 kPa) or 70 ft. (21.4m) total dynamic head (TDH) throughout the service cycle of the filter. Unfortunately, small systems may employ a pump capable of developing only 8 to 10 psi (55 to 70 kPa).

Thus, flow rate, filter media porosity and pressure all work together to affect solids retention by the filter in a given period of time. It is possible to use coarser filter media that offers a higher flow rate, even though the particle retention efficiency is less. This is because the two together provide more solids removal, compared to the combination of low flow rate and dense filter media.

In general, the coarsest possible filter media should be selected to give the best clarity. Often, if the filter chosen does not provide the clarity desired, the plater may select a denser media that loads up faster and in the end removes less solids. At the other extreme, it is possible to go to a coarse media and not get any filtering at all, even though the flow rate is very high.

A judgment must be made, with all aspects of the application considered. The bottom line is to achieve the highest solids removal, because this maintains the cleanest tank and gives the fewest rejects.

Some of these points are difficult to explain and often overlooked. Most filters in use today are undersized and therefore inefficient. In an industry where most products are bought on specification, it is important to determine exactly which combination of components gives the right results and write specifications accordingly.

Filter servicing

Infrequent servicing of filters adversely affects flow rates. One and one-half times the average flow rate through the filter can be achieved if the filter is serviced when the flow rate has been reduced by one half, as compared to letting the flow rate fall to zero. Water should be filtered before it is added to solutions. Agitation air should also be filtered.

High-pressure air for agitation often is recommended because equipment is available to remove all suspended water and oil, and carbon can remove the oil vapors. Air from low pressure blowers, on the other hand, can only be filtered with rather coarse media, which allows too many particles to pass into the plating solution. This means that the solution filter must be able to pick them up.

Other considerations

In designing a system, don't forget the accessories. Valves may be added to control or direct flow. A chamber for priming the pump or for mixing slurries for precoating filters may be desired. Put in a pressure gauge to indicate the condition of the filter, as filter clogging is related to pressure drop. Always allow enough space for filters and

QUESTIONS ABOUT PLATING FILTRATION

Q. Exactly what can the proper filter do for me?
A. A lot. It can reduce plating roughness, reduce plating time from increased agitation, provide better throwing power, remove solution surface scum, eliminate tank pump-out, and prepare your solution for organic impurity removal.

Q. How can all these benefits be accomplished?
A. It's important to pump the solution at a high enough flow rate so that the solution passes through the filter frequently, for optimum clarity. If dirt load is high, increase the amount of filter surface or select a type of media that better meets the specific situation.

Q. What are some of the media choices?
A. There are surface types such as flat sheets of paper cloth, or cylindrical types, such as tubes of fiber, ceramic, or sintered metal. There are also bags, discs, sleeves and, of course, depth cartridges.

Q. What might work best for me?
A. It depends on your particular problem, and an individual analysis is required. Generally speaking, the coarser the filter the better, because it means increased dirt holding capacity, less frequent cleaning or changing of media, and less restriction to flow.

Q. Exactly what is coarse filtration?
A. It refers to the openness of the weave or winding of the filter media. Coarseness is a relative term; even very dense filter media might be referred to as coarse in an individual context. A 0.45 micron filter traps fine particles but it would be referred to as coarse compared to a 0.25 micron filter. A 10 micron is coarse compared to a 5 micron, and so on. Generally speaking, 15 micron works very well for most plating baths.

Q. How can I best use coarse media?
A. Increase your tank turnover rate to compensate for the lower particle removal efficiency. This can be done by increasing the flow rate of the solution through the filter, or increasing the size (capacity) of the filter, or both. The result is higher particle removal and a cleaner solution.

Q. What happens if I filter too fine?
A. Too many people think that a fine filter automatically provides more efficient filtering. Fine filters tend to plug quickly, much sooner than a coarse filter. This reduces flow rate which in turn reduces tank turnover which results in reduced solution clarity. The concentration of contamination will increase to the point where ultimately batch treatment may be required. Batch filtration was a common practice in years past; with modern filtration techniques, it's not necessary to shut down for batch treatment. Filters and plating baths can stay in operation indefinitely with no loss of solution clarity or plating efficiency.

Q. What if I need carbon for purification of my solution?
A. Chambers for purification provide for the most convenient adsorption of organic impurities with the use of granular carbon. Adsorbency of the granular carbon is assured of reaching the maximum when the solutions are prefiltered for the removal of solids prior to passing the liquid over the carbon; this makes it possible for only clean solution to come in contact with the granular carbon, which prevents the carbon surface and pores from becoming coated or plugged with solids. Carbon adsorbency is thus assured of retaining its maximum efficiency until all of the adsorbency afforded by the granular carbon is used right down to the very core.

Q. Is granular carbon as adsorptive as powdered carbon?
A. Yes - tests have shown that. Surface area of activated carbon is the internal pore surface area which is compared to a complex network of caverns and accomplishes the adsorptive phenomena. Surface area of SERFILCO Hi-Surf 8 x 30 mesh is 1000 sq. meters per gram. Surface area of one commonly used powdered carbon is 650 sq. meters per gram.

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