Cartridge In-Tank Filtration Systems

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FACT SHEET

This fact sheet, which discusses advantages and disadvantages of cartridge in-tank-filtration. is one in the Metal Finishing series produced by the North Carolina Division of Pollution Prevention and Environmental Assistance (DPPEA). The series also includes <u>In-Tank Filtration Systems; Bag In-Tank Filtration Systems; Disc In-Tank Filtration Systems;</u> and <u>Identifying and Reducing Contamination in Metal Cleaning, Plating, and Rinsing Baths</u>. These fact sheets are designed to assist industry professional and others interested in waste and cost reduction opportunities associated with fabricated metal operations.
Please contact DPPEA for assistance or additional information.

Introduction

The use of in-tank filters cart be effective for controlling and removing many of the contaminants that accumulate in plating process tanks. In-tank systems differ from traditional filter systems in both size and pumping mechanism. An in-tank filter typically consumes less than 0.12 ft^3 of tank space[1] and operates by vacuum flow as opposed to pressure flow. The number of individual filter cartridges used on each in-tank unit may vary with tank size between 1 and 4. The approximate costs and pump size most appropriate for a particular tank capacity arc listed in Table 1,'

Table 1. Cartridge Filter Unit Costs/Tank Size

Size of tank, gals	Flow Rate, gph	Unit price, $
1-200	1.200	440-510
200-500	3,000	850-930
500-1,000	5,000	975-1.050
1,000-2,000	use multiple pumps	

Note: Pump prices are for CPVC; add approximately $100 for polypropylene

Solution Agitation

In-tank filters are designed so that the return solution flow can be directed to provide additional tank agitation. Agitation of the plating solution is extremely beneficial to the plating process. The entire process operates more efficiently, and the inconvenience of sludge build up and cleaning is reduced, These efficiency improvements result from the following conditions:[2]

1. A higher rate of solution turnover and mixing keeps the chemical composition of the bath homogeneous, which results in increased efficiency. Furthermore, thermal and chemical stratification is prevented (i.e., the tank heaters in a thermally homogeneous bath last longer because they are able to operate more efficiently).
2. Fresh, clean solution constantly passing over the anodes results in a more uniform anode dissolution, and scum and scale are less likely to buildup on tank walls or anode bags.
3. Sediment build up on the tank bottom is reduced by continuous agitation, which reduces the need to de-sludge tanks (i.e., it is estimated that in out-of-tank filter chambers and pipes. in addition to the solid products, 1 to 10 percent of the process bath chemicals and ions are retained in sludge and carbon beds and/or are lost as residue).
4. Liquid agitation eliminates increased contaminants from the compressor (such as dust from air and oils) and neutralizes alkaline solutions through the addition of CO^2 that is produced by air agitation.

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Filter Types and Filtration Mechanisms

The two most common types of cartridge filters are wound and poly-spun

- Wound cartridge filters are made of a variety of materials, and pore size can range from 1 to 100 microns, The filter media are wound from cotton, polypropylene, or other synthetic fibers for compatibility with the bath solution. The fibers are wound to form a surface of diamond-shaped openings, As the layers build up, the increasing circumference of the cartridge causes the diamond-shaped cartridges to become progressively larger. The larger particles are removed first in the larger openings, and each succeeding layer removes smaller particles (i.e., depth filtration),
- Poly-spun filters are thermobound polymer fibers with pore sizes ranging from 1 to 100 microns. The poiy-spun filter is graded in density from the inner to the outer core to provide depth filtration capabilities. These filters can be purchased as disposable or reusable.

Material Selection

The type of filter material used with the in-tank filter unit can vary widely. The filter is more suited to certain solutions according to material type and micron size. Typical cartridge filter materials include cotton. polypropylene. non-polypropylene modified polymer, modacrylic, CPVC, and PVDF. For disposable filters. available sizes range from 4 to 50 inches with micron ratings ranging from 100 to 1. For reusable filters. the available sizes range from 4 to 20 inches with micron ratings of 75 to 1. Vendors should be consulted on the most appropriate material and filter size for each process bath.

A common type of filter material is the reusable chlorinated polyvinyl chloride (CPVC) poly-spun filter that can be reused from 10 to 100 times, depending on the solution. Vendors claim that these filters have been reused up to 50 times on precious metals, nickel, copper, and acid treatment baths.

Table 2 presents the approximate cost of two commonly used media materials - polypropylene and non-polypropylene.[3] The comparison includes cost per dirt-holding capacity, which may give additional indication of filter life and performance.

Table 2. Filter Media Cost Per Unit Size

Material	Sizes, microns	Length, inches	cost, $/filter	Dirt-holding capacity. oz	Cost/dirt-holding capacity, $/oz*
Polypropylene (Reusable)	10, 5, 1	6, 10, 15, 20	6-20	8-12	0.75-1.66
Polypropylene (Disposable)	1-75	4-50	1.10-16	12-14	0.09-1.14
Non-Poly-propylene	30, 75	10, 15. 20	18-28	18-20	1 -1.4

*Figures are based on a 10-inch filter,

Continuous Carbon, Metals, and Oil Removal

Carbon aids used in conjunction with cartridge filters have proven successful in eliminating organics and other contaminants from process baths. A bag, or carbon attachment, containing activated carbon pellets permits simultaneous filtration and carbon removal. Thus, while the in-tank carbon system is purifying the solution. it is also removing very fine particles. Additional] y, when these attachments are used during continuous filtration, they serve to extend cartridge life. This process occurs as the porous bag material (150-micron) surrounding the cartridge prevents larger particles from entering and clogging the inner filter cartridge. Most dust and airborne contaminants range from 50 to 1,000 microns and are a major cause of cartridge fouling,

A similar system involves a bag called a carbon/resin pack that fits over the filter cartridge. The capability to use carbon and resins in the same system makes it possible to remove both organic contaminants and resin-treatable metallics from the solution without interrupting production schedules.

In-tank skimming devices, which work in conjunction with the filter, are also available to remove tramp oils and other contaminants floating on the bath surface. These in-tank skimmers remove slicks and debris from the surface and trap them in submerged filter media,

Tips for Selecting In-Tank Cartridge Filter Systems

When assessing the type and size filter unit and media to purchase, several additional points should be considered:

- The size and amount of dirt in the plating/cleaning solution will determine the number of cartridges or surface area necessary as well as the filter micron rating. A rule of thumb is 2/3 ft^2 of surface area per 50 gallons of solution. Zinc plating solutions may require slightly more surface area per 50 gallons.[4]
- During an initial batch cleanup of a dirty tank that has no filter aids, filtering should begin with a 75-micron filter. When the flow rate slows, the media should be replaced; and filtering should continue until all heavy soils have been removed. A 50-micron filter should then be used for several hours before it is switched for a 20- or 10-micron filter. For baths with continuous filtration, 15- to 3 O-micron cartridges are recommended.[5]
- For alkaline solutions, a 30-micron filter is common, while 50 or 75 microns are standard for acid solutions, A 10-micron filter is common in plating and printed circuit solutions. Cleaning baths. iron phosphate tanks, and some zinc chloride plating baths require coarser filters (i.e., 30 to 75 micron).'

Filter Life (Dirt-holding capacity)

Pump pressure is extremely important in order for filters to achieve maximum efficiency. The filter life efficiency (or dirt-holding capacity) is dependent on both the maximum pressure rating of the filter cartridge and the pressure capacity of the pump. As the cartridge accumulates debris from the solution, the resistance to flow through the filter increases, and greater pump pressure is required, For example, a 50-psi filter cartridge requires a pump maintaining 50 psi to achieve maximum filter life. In many systems, pumps are undersized and cannot maintain adequate pressure to maximize utilization of the filter.

> **The "Pre-Coating Effect"**
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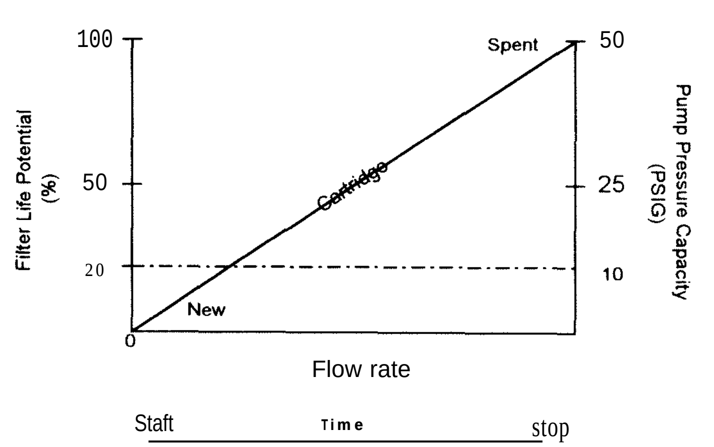
> The particle retention characteristic or efficiency of a filter actually improves with time because of the pre-coating effect. That is, as solids are collected on the filter media, progressively finer particles are retained. The second half of the filter's life is. therefore, the most effective. Unfortunately. many pumps are incorrectly sized and, thus, unable to utilize even the first 50 percent of the filter's life.

Consider the following. A wound filter cartridge with a pressure capacity of 50 psi is filtering a plating bath. A typical 3/4-hp in-tank pump delivers a maximum discharge head of only 10 psi (Figure 1), As the pre-coating begins to improve particle retention efficiency. the pump flow stops, and the most effective portion of the cartridge life goes to waste, Assuming the filter is operated until zero flow. the filter life efficiency is only 20 percent of its potential life. However. the filter efficiency is actually less than 20 percent because the benefits of the pre-coating effect. which increase with time, have not yet been realized.

Figure 1: Pump Pressure Versus Cartridge Life Efficiency.



To optimize filtering efficiency:

1. Contact your filter system supplier. Determine the maximum pressure rating of the current cartridges and the pressure capability of the pump.
2. If the pressure capacity of the pump is not as least as high as the pressure rating of the filter. resize the cartridges or resize the pump.

Table 3 lists in-tank filter vendors.

Table 3. In-Tank Filter Vendors

Camac Industries	(201) 575-1831
Custom Masters, Inc. (Flow King)	(407) 331-4634
Penguin Pump Industries	(818) 504-2391
Serfilco@, LTD	(800) 323-5431

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[1] Flow King Filters Systems Catalogue, 1994-95 cd., p. 13.
[2] Horvath, Gene. "The Case for In-Tank Filtration," ***Products Finishing,*** Vol. 53, No. 5., p. 103, Feb. 1989.
[3] Flow King Catalogue and Personal Interview with Gene Horvat.h, August 1994.
[4] SERFILCO Technical Bulletins. Service Filtration Corporation, 1987.
[5] guidance on selecting Flow King filter cartridges.