Extending Cleaner Life Through Particulate & Oil Removal by Filtration & Coalescing

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Suspended solids and oil substances can be removed from cleaners, extending their useful life and improving surface finishing. Removing suspended solids and oil and not contributing to the contamination of plating or anodizing solutions, electrophoretic painting, or other metal or plastic surface preparations results in less frequent cleaner purchases and a reduced load on the pollution abatement sytem. From the heavy internal scale and other solids contained within the structure of tubular furniture to highly contaminated jewelry—whether the parts are formed from plastic or are metallic, formed from stamping, casting, machining or drawing—no cleaner lasts indefinitely. It also seldom performs at its optimum level from week to week, without treatment. Therefore, if a part to be plated is expected to be free of roughness as a result of codeposition or from blemishes resulting from organic contamination, all the pretreatment operations (cleaners, acid pickles and even rinses) should be evaluated to determine how their integrity may be best maintained. This paper focuses on cleaners, but its lessons are equally important for other pretreatment operations. Filtration, impingement of the cleaning solution on the parts to be finished through eductor (liquid) agitation and oil removal, coalescers vs. bacterial treatment, and carbon purification will be discussed.

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Cleaning and cleaning solutions are receiving more and more interest from plant management. There's even an annual convention devoted exclusively to all facets of it. Cleaning solutions in the surface finishing industry have not been given their due. This is due to the fact that the various types of cleaners (alkaline, principally) were highly caustic and non-corrosive. In addition, they were relatively inexpensive when compared to the process solutions (zinc, nickel, copper, chrome etc.) and were frequently dumped to the pollution abatement system when they become heavily contaminated with oils and/or particulate matter.

Now, however, several factors make the extension of cleaner life necessary. Some of these factors are:

- Rejects — pretreatment tanks too highly contaminated with particulate and/or oil are causing costly rejects.
- The upset of the existing waste treatment systems by "slugging" it with excess alkalinity and oils.
- The cost of cleaning tank makeup with more sophisticated cleaning solutions, the heat-up costs and any down-time which might be associated with the make-up process.

For many years, Jack Berg has championed the cause of proper handling of the pretreatment processes. The philosophy he has even goes beyond the obvious filtration and removal of oils from soak, electro-cleaners and spray cleaner solutions. Several years ago, he authored an article entitled "Working Backwards" (from the plating tank where roughness and rejects occur). As you go backwards you ultimately come to those parts which may have been sand blasted, spun in a chip wringer, blown off with compressed air, etc. At this point, they are ready to be immersed in a reservoir of cleaning solution or sprayed with a cleaner and then rinsed in a conveyorized tunnel where the liquid is allowed to drain from the parts. Particulate on or in the parts account for 50 – 75% of the solids that enter the process tank. Wouldn't that be the point at which filtration and oil removal from the cleaner tanks and last rinse prior to plating should take place? The parts would be cleaner going into the plating solution and therefore, there would be less chance for costly rejects!

Like the old "saw" in the real estate business indicating perceived value—*location, location, location,* this situation of striving for quality, lowering costs and creating a more environmentally friendly atmosphere cries out for *preparation, preparation, preparation*.

So what surface finishing processes are in need of this *preparation*?

- Plating (Electrolytic and electroless)
- Phosphating
- Anodizing
- Chromating
- Bright dipping
- Parts washing
- Painting
- Pickling
- Galvanizing

— a much broader range of processes than the average person may think. In addition to the filtration and oil removal which will be discussed, some of these may require further treatments such as magnetic particle removal (degaussing) caused by the buffing, cutting, polishing and grinding processes.

At what operating temperatures, make-up concentrations and dwell time do these various cleaners operate?

SOAK CLEANERS — most metals
- Temperature — 150°F to 200°F
- 8 to 12 oz. per gallon
- 3 to 5 minutes

ELECTROCLEANERS
- 140°F to 200°F
- 4 -10 oz. per gallon
- Dwell time – 15 seconds to 2 minutes for zinc, copper and brass
  – 1 to 5 minutes for steel
- Current density –10 to 30 ASF (amps per sq. ft.) for zinc and copper
  – 50 to 100 ASF for steel

SPRAY CLEANERS
- Temperature – 100°F to 180°F
- Soak – 5 to 12% by volume
- Spray – .5 to 3% by volume in water

SOAK CLEANERS
- Temperature – 140°F to 180°F
- 6 – 8 oz. per gallon
- Dwell time – 2 to 5 minutes

What is removed by these various cleaners and cleaning methods?
- Dust
- Chemical contaminants (in the make-up water)
- Anode sludge
- Metallic and plastic particles
- Residue from heat treating (if the heat treater doesn't filter the quench oils)
- Greases and oils
- Mold release

Surely, even one of these contaminants, when adhering to the parts and dragged into the subsequent rinse and then the process solution itself, would be bad enough. The reality is that there are usually 2 or 3 of them.

Since the bulk of cleaners are in static tanks, a means of removing the suspended solids and greases and / or oils are necessary to prevent potential rejects. Following are means of separating the contaminants from the cleaners –
- Bag or cleanable sleeve filters (Figures 1 and 1A)

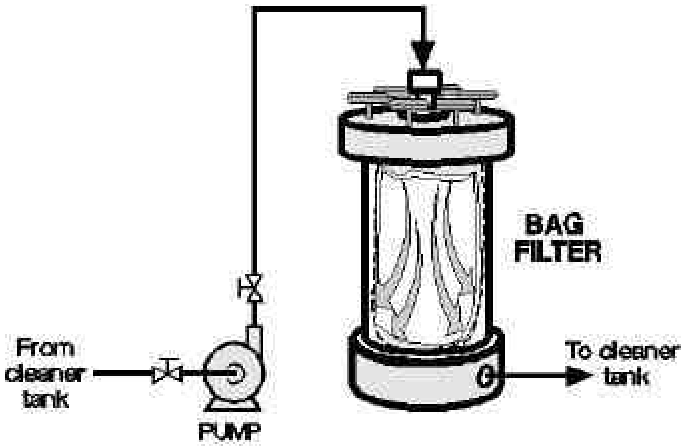


Figure 1

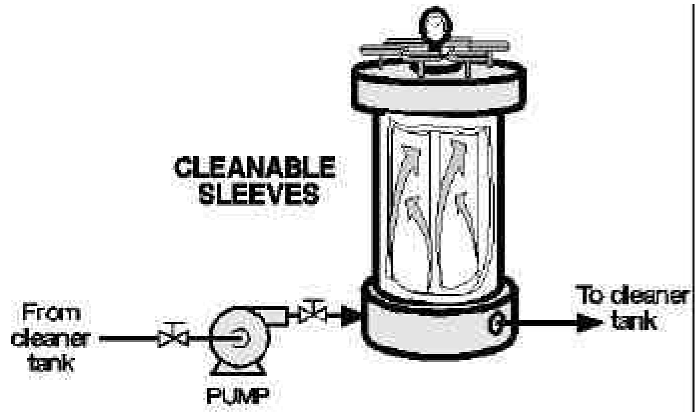


Figure 1A

- Cartridge filters (Figure 2)

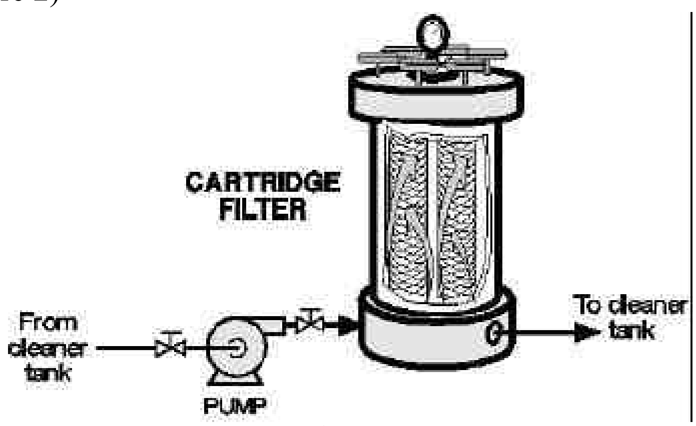


Figure 2

- Index and bed automatic gravity filters (Figure 3)

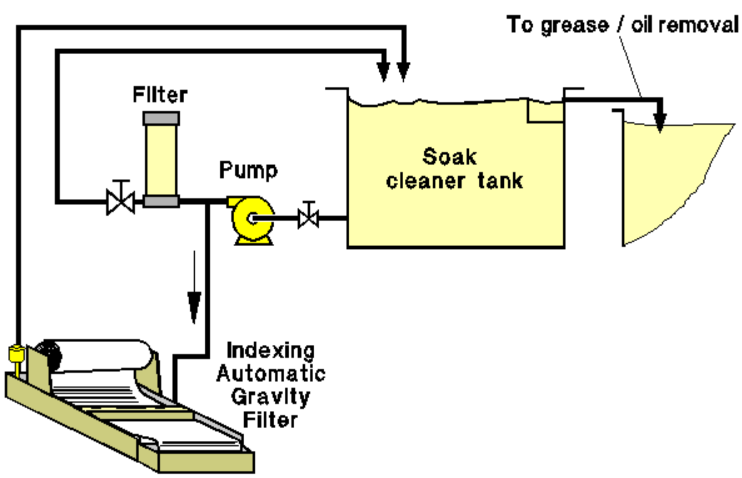
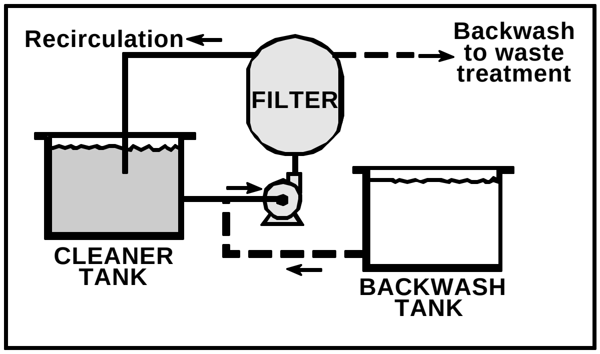


Figure 3

- Automatic backwashing filters (Figures 4A and 4B)



AUTOMATIC BACKWASH FILTER SEQUENCE OF OPERATION

A. Filtration
B. Air purge solution back to cleaner tank
C. Backwash with clean water
D. Air purge backwash to waste treatment

Figure 4A

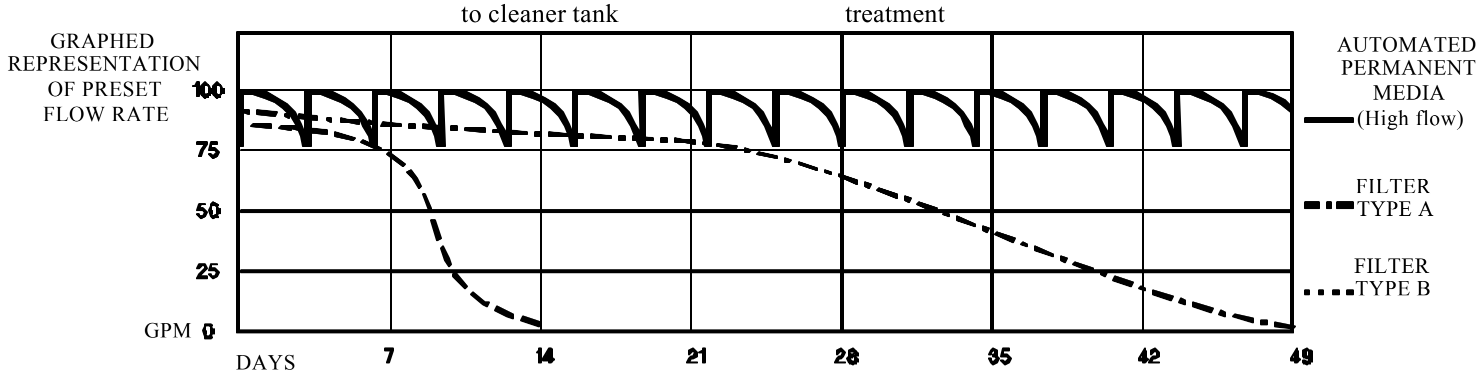


Figure 4B

The characteristics of the state-of-the-art automatic, permanent dual media filter set it apart from all other types of filters, as illustrated by Figures 4A and 4B. Flow is precisely maintained between preset flow limits. Then particles which have been retained in the media bed are backwashed to an existing waste treatment system, thus maintaining the high flow rates which prevent contaminant build-up.

A valuable aid to maintain particles in suspension so that the filters can capture them, is a pump powered eductor system. These systems are often used in the process solutions to —

- Reduce airborne emissions by 90%
- Reduce heating costs by up to 30%
- Eliminate gas pitting
- Permit increased current
- Improve throwing power and deposit density in low current density areas
- Reduce carbonates in alkaline processes

These eductor systems can be very effectively used to impinge on the parts and allow faster cleaning (less time is necessary for the parts to be in the solution). This lessens the degree of attack on metallic substrates resulting in less dissolution of metal in the cleaner. Presence of the dissolved metal in the cleaner causes it to become less efficient (Figure 5). In summary, pump powered eductor systems are necessary in the cleaning process to ensure that particulate contaminants remain in suspension where they can be successfully removed by filtration.

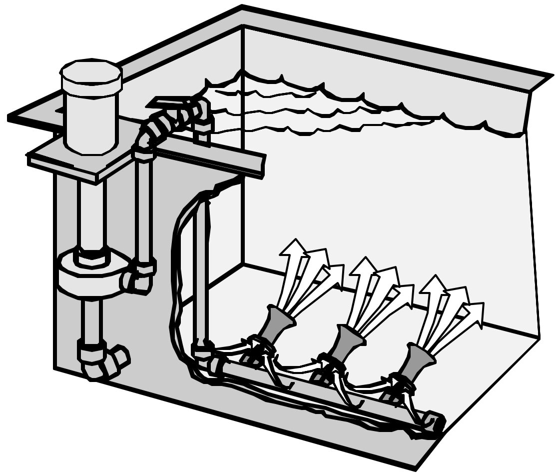


Figure 5
PUMP POWERED TANK MIXING EDUCTORS

Oil is as much of a problem in the cleaning process as are the suspended solids. The preferred method of removing oils which are not emulsified is coalescing. The heart of the liquid / liquid filtration system is a very special cartridge filter element. Unlike the common cartridge filter element, it is subjected to a reverse flow, i.e. from the inside out. The media has selective affinity for the non-aqueous phase. As the oil passes through, it adheres to the element fibers until fine droplets of oil gather on its surface to form globules. These then rise because of their lower specific gravity compared to the aqueous phase. A minimal differential of 0.09 in specific gravity between the two phases results in optimal separation. Solution temperature should be no higher than 150°F to assure that separation will occur.

As is seen in Figure 6, the coalescing chamber has two discharges, one for the light phase (oil) and one for the cleaner. The cleaner is usually discharged continually at full, but controlled flow with the oil being skimmed off from the top of the tank.

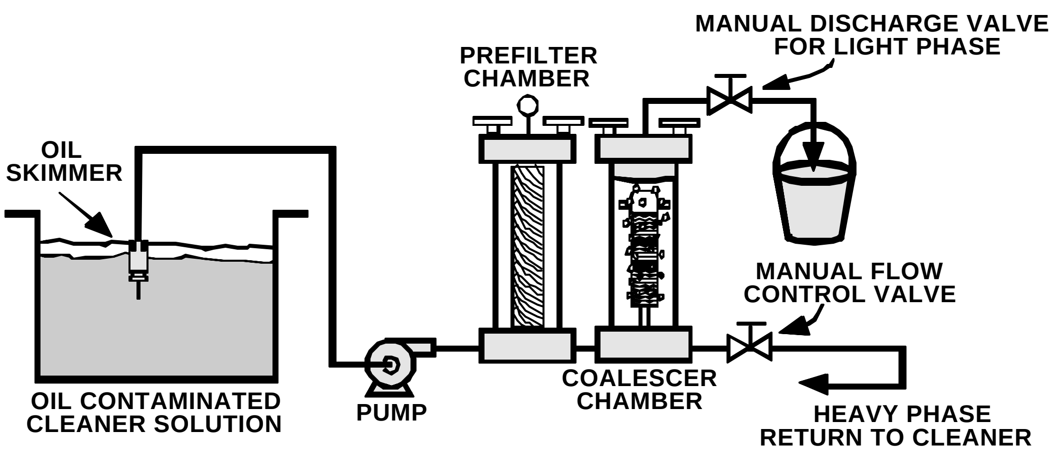


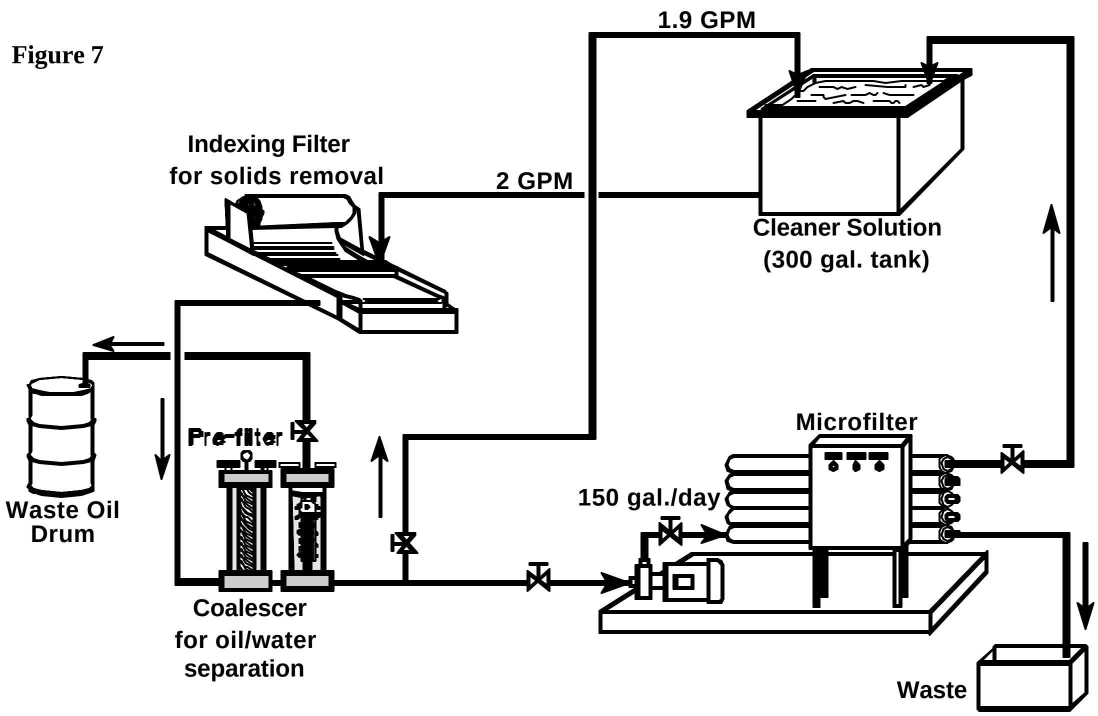
Figure 6
OIL SEPARATION FROM
AQUEOUS RESERVOIR

In cases where the overflow from the cleaner to the coalescing pump is not continuous (because of the large displacement of liquid in the cleaner tank by the work and, if applicable, associated carrier baskets, barrels, etc.), it is best to skim and coalesce the drag-out rinse prior to the cleaner. For those unfamiliar with non-emulsified oil contamination problems, we offer Photo #1. This is an all too frequent circumstance when processing tubular pieces or barrel plating. What is pictured is a side tank as shown in Figure 6. Here the floating oils will be skimmed off and totally removed using a coalescer.

Photo 1

Microfiltration (Figure 7) is yet another approach to extending cleaner life. The cleaner is sent through a conventional cleaner system at the rates shown (for a 300 gal. tank, for example). A sidestream flow at 150 gal. per day is pumped through crossflow membranes (microfilter). There the emulsified oils are concentrated and rejected into a waste disposal receptacle. The purified cleaner is returned to the tank. The membrane area is sized to purify the tank volume once every 2 days.

Figure 7



In addition, certain types of cleaners themselves extend the life of the solution. Modern cleaners contain surfactant and complexing agents. Today's high performance aqueous soak cleaners employ combinations of alkaline builders such as caustic soda, sodium metasilicate and phosphates, in addition to the special complexing agents. They have the ability to retain trace oil and metal while remaining efficient. However, in time even these cleaners become increasingly contaminated and must be dumped.

In addition to those separation methods already discussed, bioremediation technologies are being more accepted. These terms must be defined prior to a full explanation of "bug" treatment.

Bioaugmentation: a general term describing the addition of microorganisms or enzymes to a material, to remove unwanted chemicals (i.e. oil spills). Bacteria are the most common bioaugmentation organisms.

Bioreactors: treatment of contaminated substances in a vessel containing organisms or enzymes. For example, removing cyanide residue from gold mining wastes.

A major cleaner manufacturer and others offer a system which continually receives spent soak cleaner into a bioreactor where it is continuously rejuvenated by the microorganisms and then replenished and returned to the soak clean tank in optimum condition. (Figure 8)

BIOREMEDIATION

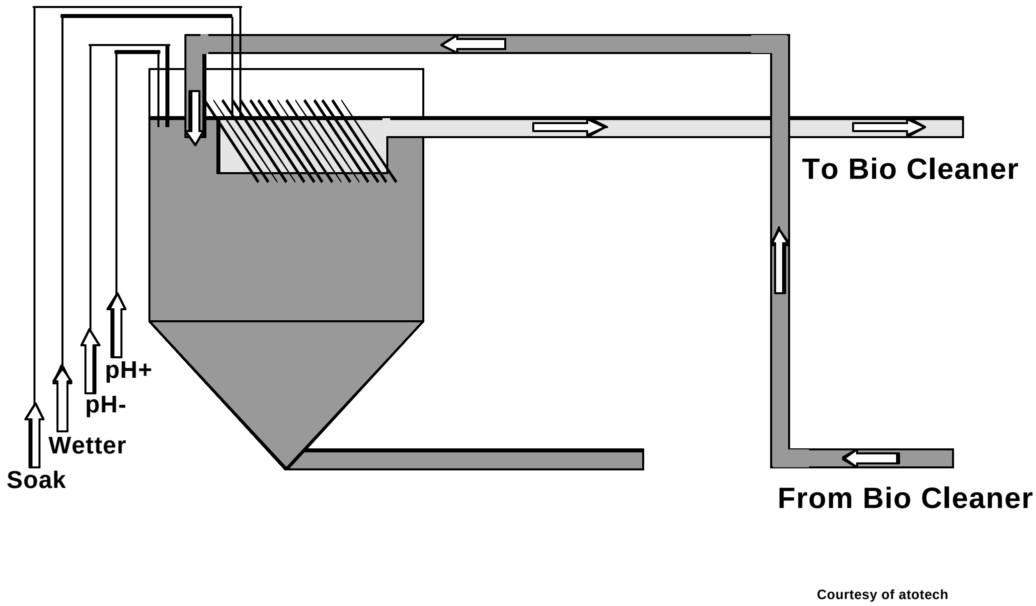


Figure 8

In order for the microorganisms to survive, certain parameters must be adhered to:

- pH must be maintained about 9.0. Above 9.4 the bacteria become inactive. Below 8.8 they become very active and destroy the surfactants.
- Temperature must be maintained between 40°C and 50°C. Below 40°C the bacteria become dormant. Above 55°C they are killed.
- The spent cleaner bath must be air agitated as the bacteria need oxygen to live.

The microorganisms have no part in the cleaning process. They only consume the oil emulsions converting them to CO_2, water and other simple molecules. The bacteria are natural and are introduced via the incoming oils and other surfaces. The bacteria multiply in direct proportion to the volume of their emulsified oil food source.

These units are used on all of the applications using cleaners mentioned earlier in this paper. The bioreactor supplier claims a closed loop system using their monitored reactor can eliminate or minimize hazardous waste disposal costs, reduce replenishment volumes, can create a “never dump” situation and is easily installed in existing process lines. The reactor is said to remove insolubles, monitor and maintain temperature, pH and surfactant levels in the closed loop system as well as aerating the solution.

In addition to being a premier metal finishing facility, Anoplate Corporation of Syracuse, New York, has been a leader for many years in environmental pursuits. After having seen the “bio-cleaners” used by Anoplate, Jack Berg was quite surprised. In a private communication from Milt Stevenson, Jr. to SERFILCO, he reported that Anoplate has used “bio-cleaners successfully for two years . . . without having to dump the cleaner tank. The “bugs” are operating or rather “chewing” on 4 cleaners.” Mr. Stevenson further reports that they actually take oil from a skimmer in another line and feed it to the “bugs” in the 4 cleaner tanks mentioned (black oxide, barrel dept., zinc, aluminum chromating). He quips, “Happy bugs make for cleaner parts”.

In summary, there are a multitude of cleaner extenders, conventional filtration, automatic filtration, coalescing, microfiltration, bioorganisms and the latest and best cleaners. Let’s not forget the importance of extending cleaner life today as opposed to the practice of 10 years ago when dumping existing waste systems with their previously mentioned problems was standard operating procedure. Let’s also recognize the importance of filtering and carbon treating the rinse just prior to the process tank to absolutely minimize reject parts.

BIBLIOGRAPHY

1. Barry Williams, *“White paper” Soak Cleaning using Bioremediation Technology*, Atotech USA, Inc.
2. Private communication with Nicholas Papa, President FPI Systems, North Haven, Connecticut
3. Private communication with Jack Berg, President SERFILCO, Ltd., Northbrook, Illinois
4. SERFILCO Sales literature, Bulletin F-692C, Northbrook, Illinois
5. David Heubel and Ken Olasbuk, *Plate Magnets Keep Caustic Cleaning Solution Free of Iron Particle*s, Eriez Magnetics, Erie, Pennsylvania and Voto Mfg. Sales Co., Stuebenville, Ohio
6. *Solution Filtration*, 2002 Products Finishing Directory, Cincinnati, Ohio
7. Clean Tech Magazine, Witter Publishing Co., October 2001
8. SERFILCO Sales Literature, Bulletin TF-144A, July 1999
9. SERFILCO Sales Literature, Bulletin TO-100B
10. Vince Panone, *Aqueous Cleaning Basics*, Lewis Cleaning Systems, Oxford, Connecticut, Products Finishing, January 2002
11. E.P.I. technical literature re: *Cleaning Processes from the Internet*, Electrochemical Products, Inc., New Berlin, Wisconsin
12. Cleaner Production in the Metal Finishing Industry (an annotated guide to resources available on the internet) http://www.svti.sk/cleanvoc.htm
13. Richard W. Crain, *Extending Cleaner Life in Surface Finishing*, SERFILCO, Ltd, Northbrook, Illinois (Presented at Clean-Tech 2001)
14. Private communication with Milt Stevenson, Jr., Anoplate Corporation, Syracuse, New York
15. Private communication with Cliff Roy, Roy Metal Finishing Co., Conestee, South Carolina