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White Paper

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The Importance of Proper Rinsing in Metal Finishing

Rinsing is a dynamic operation, referring specifically to the dilution and subsequent removal of surface films and contaminants. A critical portion of any metal finishing process, it can never be neglected or minimized, for the stakes are far too high.

Far too many problems can be traced to poor rinsing resulting in the contamination of down-line process baths. By conveying the elements of good rinse practice, we're here to help ensure that such problems never happen to you. We'll touch upon line-operation considerations, equipment options, the effects of temperature, dried films, realistic cost savings related to reduced water use, and consistent rinse-water purity.

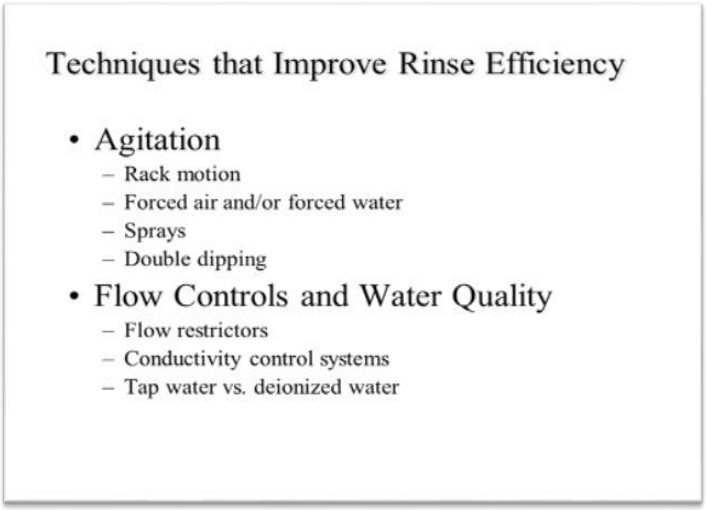
The elements of proper rinsing

Basically, proper rinsing provides a medium to wash the surface, conditioning and preparing it for the next process or for completion. Some critical rinsing factors to consider are:

- water purity
- agitation
- duration
- temperature of the medium

Rinsing parts right requires a unique combination of maximizing system layout, selecting effective support equipment and incorporating it all in a given process cycle. Compounding the complexity: Water has become an expensive commodity, its use and availability restricted in some areas.

Effectively navigating these challenges offers finishers a host of benefits. Among these are meeting the requirements and specifications of quality approved finishes; reducing demand on the waste-treatment system; minimization of rejects; conserving water and minimizing its cost; and steady and uninterrupted process-line operation.



Things to keep in mind:

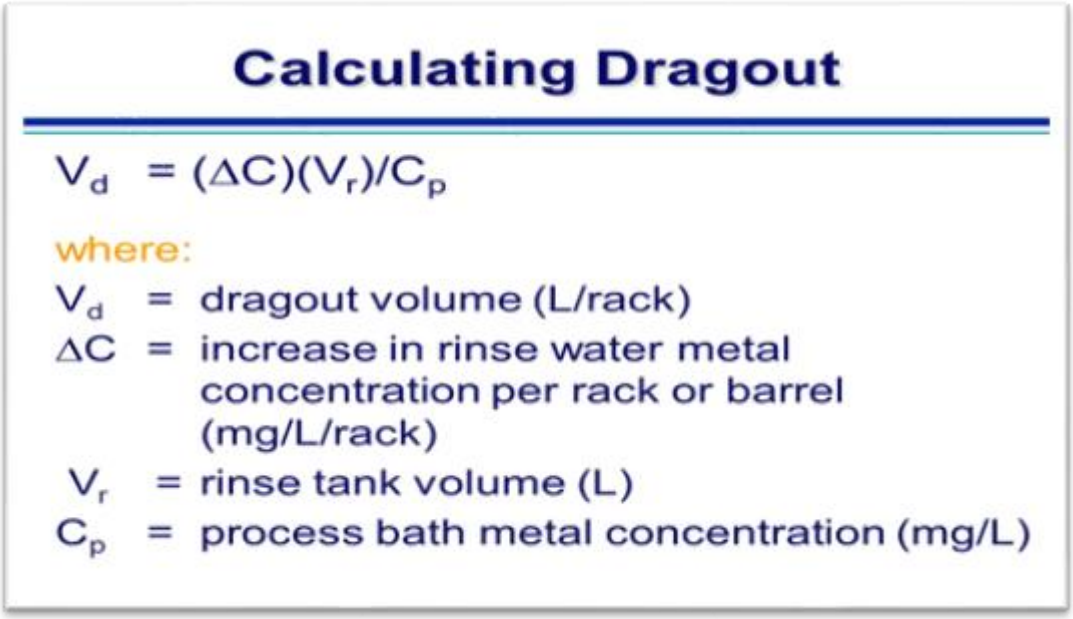
- Number of rinses in the process line
- Proper usage of these rinses
- The potential for improving efficiency by incorporating or upgrading tanks
- Sufficient and efficient water flow and agitation
- The re-use of treated water
- Consideration of easier-to-rinse treatment and finishing processes

In pursuit of improved rinsing results, observe the following:

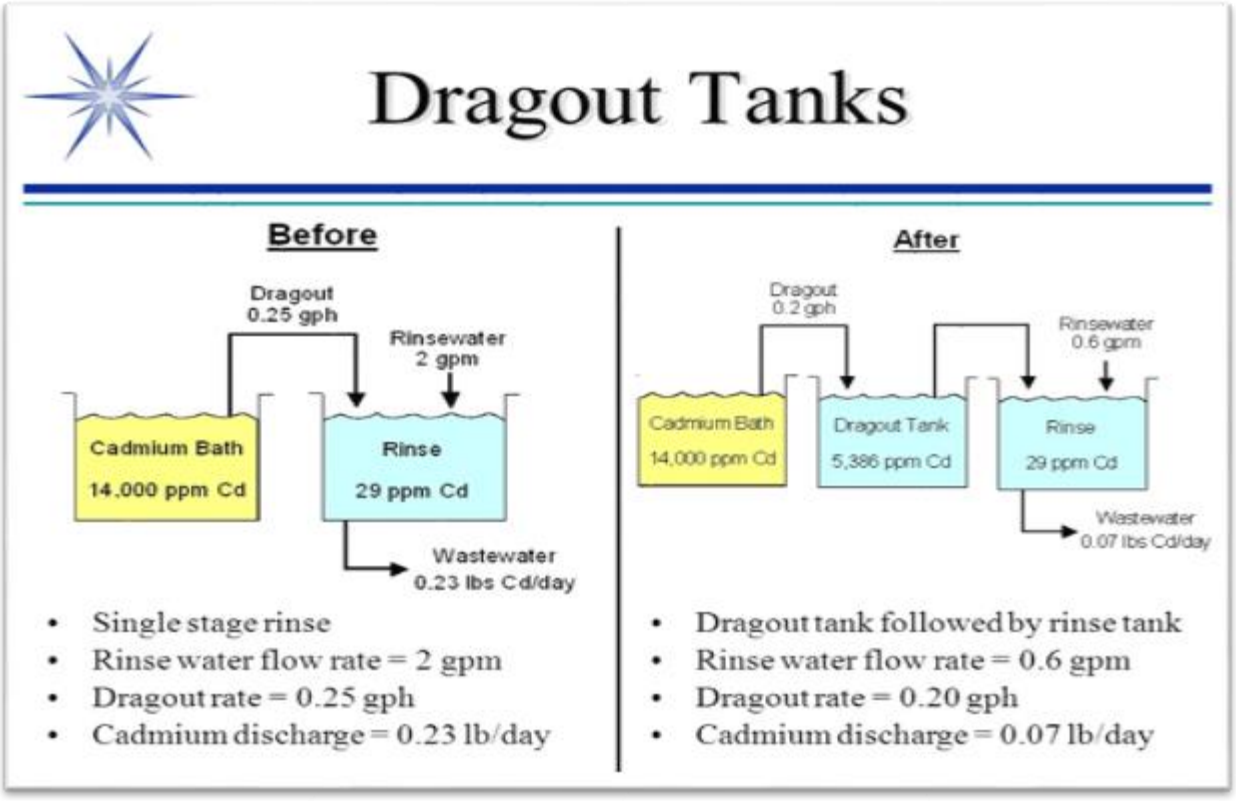
1. **Incorporate a drag out or static rinse (a.k.a., a reclaim tank)**

   This step follows immediately any treatment or conditioning tank, such as surface preparation, plating or post finishing treatment. Returning carry-over solution back to the previous tank gives rise to two important benefits:

   a) conservation and reclamation of the process solution (chemical cost savings) - minimizing contamination of subsequent rinse tanks.
   b) Consider drag out of process solution and what effect it has. Drag out of solution can be calculated as follows

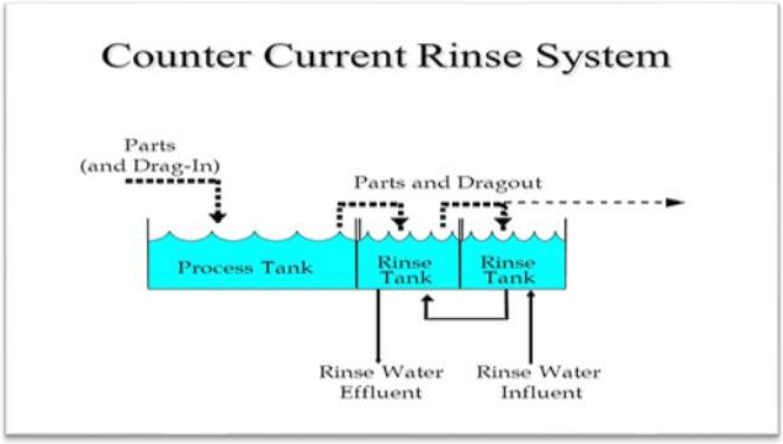


The Benefit of a Dedicated Rinse Tank Following Drag out Tank

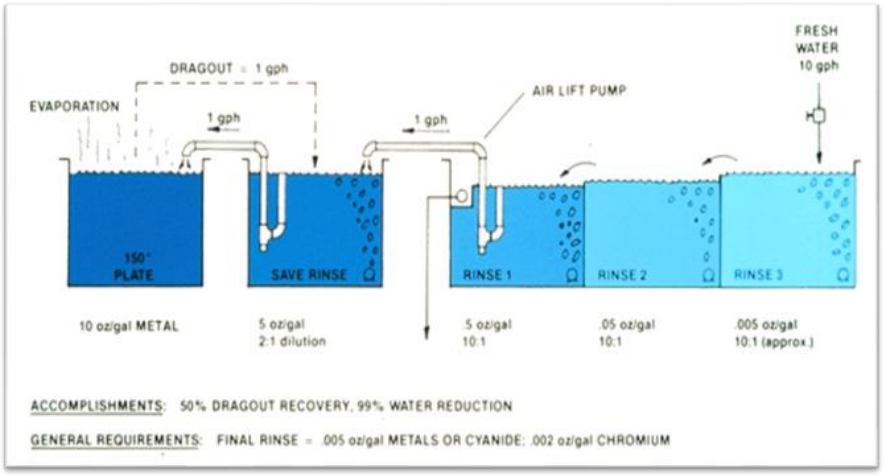


2. **Two rinses are better than one**

Time spent in two counter-flow rinses as part of a double counter flow is more effective than the same time spent in a single rinse. Rinsing efficiency can be improved from 10 – 20X, while reducing water consumption by more than 50%.



3. **Three rinses are better than two**
   a) Triple counter-flow (or current) rinsing has the effect of two or three standing separate rinse tanks, with the water consumption of one.
   b) Here's how it works: Counter flow rinsing introduces fresh water into the last rinse tank. This water cascades back through the second rinse tank leading into the first rinse tank – in the opposite direction to the movement of parts. In this scenario, the freshest, least contaminated water contacts and conditions the most thoroughly rinsed parts, while the most contaminated water contacts and conditions non-rinsed parts. Employing a triple counter flow set-up can reduce fresh water requirements by as much as 70-80%, with the second and third rinse tanks providing a dilution range from 30:1 to 40:1.
   c) Use of the counter-flow rinse system can reclaim over 75% of metal drag-out back to a plating bath. Counter-flow rinsing is especially effective in removing films in post-alkaline plating cycles. Counter-flow rinsing is often best suited for combining water conservation with quality parts rinsing. If capacity permits, using discharge water to substitute for a heated processing tank represents an additional benefit.



Positive Effect of Utilizing Triple Counter Flow Rinse System

4. **Agitation has its benefits.**

Using all of the tank's rinse water to rinse parts is a highly recommended. Movement of water in close proximity to parts affords fresher water contact. In concert with mechanical action, it is unmatched in dislodging contaminant films and any solid particles. Additionally, agitation of the rinse mitigates the challenge of lower-than-desired water flow. (Take care to calibrate agitation strength - avoid pushing fresh water out the over flow dam before it has been in contact with parts.)

Rinse Tank Fitted with Filter and Circulation Pump

There are similar advantages to ultrasonic rinsing. Its cavitation action generates scrubbing gas bubbles to provide excellent mechanical action.

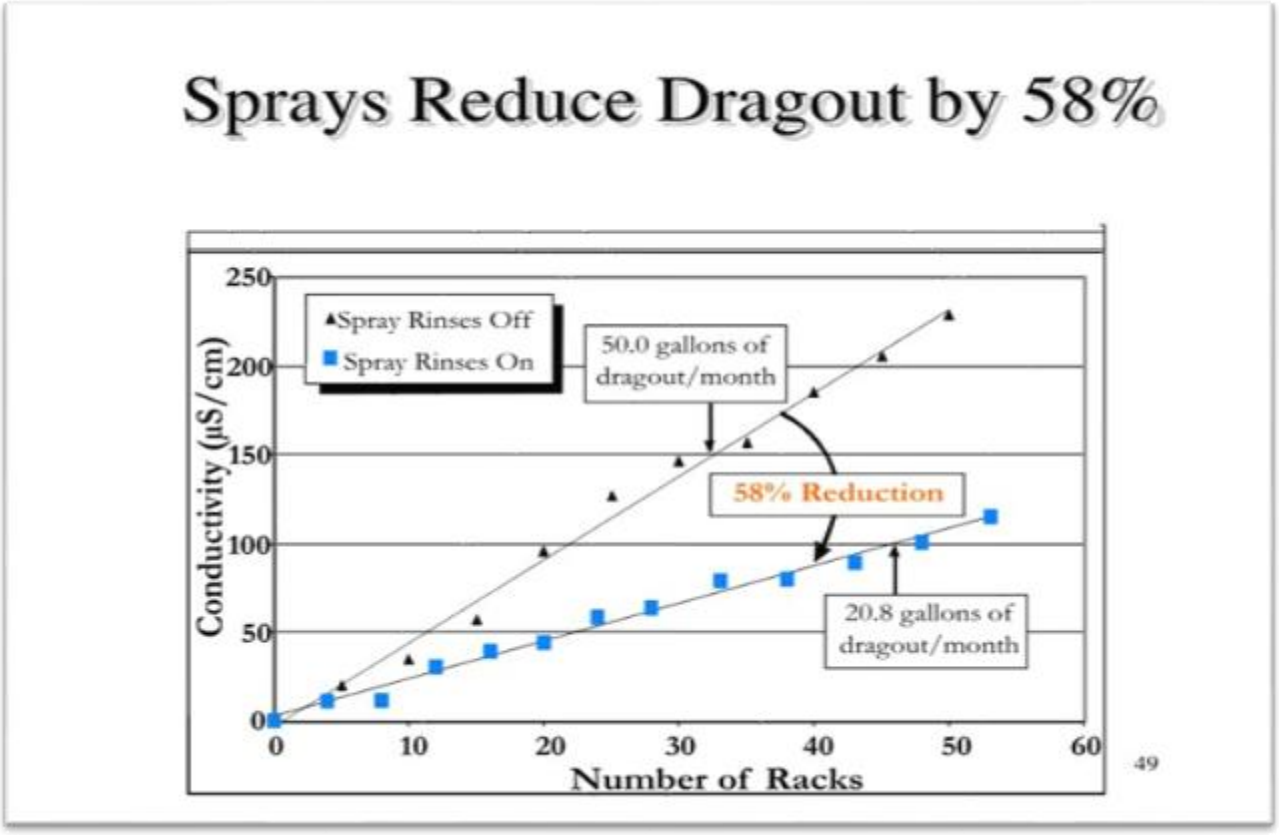
Ultrasonic Clean – Rinse – Dry Station

Agitation by air or eductor is recommended. Basically, turbulence is the goal of agitated rinsing, to remove surface films off immersed parts.

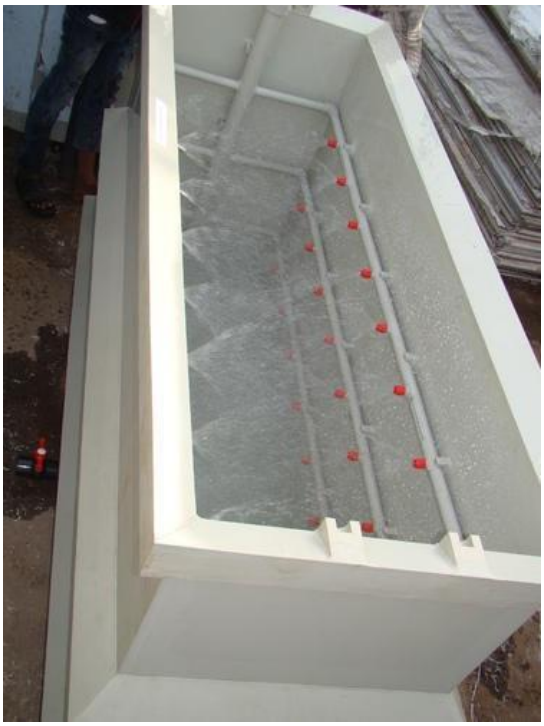
Eductors Used for Effective parts Rinsing

Although air agitation is good, an eductor can be more effective.
The air-agitated water "collides" with the part surface, not uniformly contacting it. Rather, it sweeps the part in an uneven turbulence. Air agitation provides a continuous source of air bubbles that, upon release to the surface, results in more rapid water evaporation.
An eductor is a uniquely engineered nozzle that generates a turbulent flow of water. The water pumps at a high velocity thru the nozzle, effectively contacting parts, removing any unwanted films. The eductor produces a significantly improved turbulence, providing significantly improved contact with the immersed part.

5. **Spray rinses can be surprisingly effective.**



The velocity of the spray can result in the rapid removal of surface films. while greatly reducing water use. (The downside: The inability to reach or penetrate into blind holes, recessed geometric shapes and machine-tapped holes.) Sprays can be installed directly over process tanks and activated as racked parts exit above the tank, representing an initial rinse. Alternatively, racked parts can be set into a first, empty drag-out tank and sprayed before introduction into immersion rinses.

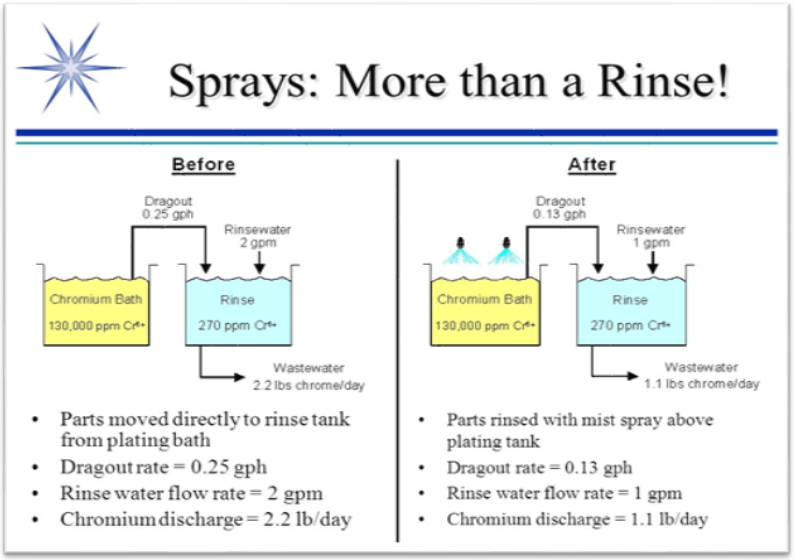


Spray Agitation in Rinse Tank

6. **Fog nozzles are also effective – and great water savers.**

   For nozzles are specifically designed for rack operations, especially heated process tanks like plating. Benefits include reduced rinsing load and process solution drag-out and preventing dry-on stains due to heated solutions. A fine density water fog is typically activated by a manual operated foot pedal or automatic sensor as the rack slowly exits above the process tank. The solution washes directly back into the same process tank. Fogging represents another excellent pre-rinse treatment before immersion in water rinses.

Benefit of Mist Spray Above Plating Tank Prior to Rinse

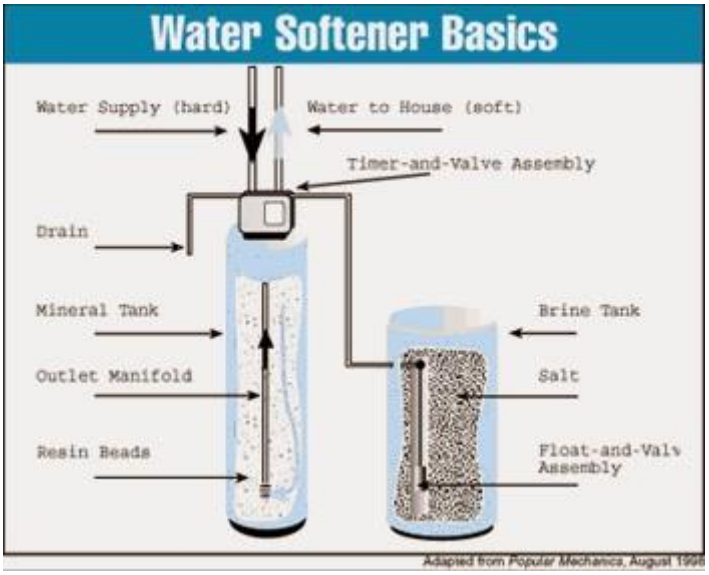


7. **Rinse tank controllers offer cost savings while providing desired volumes of fresh water.**

   a) When calibrated and set, the tank controller measures electrical conductivity that maintains a desired level of predetermined fresh rinse water in the tank. The conductivity of water increases with increased loading of dissolved salts, contaminants that can lead to adverse rinsing. Within the tank controller, which is essentially a conductivity probe, a fresh water inlet is activated, lowering conductivity to a predetermined setting and maintaining preferred rinse water quality.
   b) Automatic rinse tank controllers improve rinsing characteristics while reducing water use up to 80%. This means less water incoming from the municipality, which instantly contributes to lower water use bills.
   c) The controller operates on the measurement of water conductivity. A preset sensor automatically introduces fresh water as required to maintain the desired range of water conductivity.

8. **Making the exchange.**
   a) Ion exchange is a method by which water is “polished,” which can be very beneficial to rinsing. Dissolved metallic ions are removed in a resin bed, purifying the rinse water. Less contaminated, the water can also be reused by running it through the deionizer system. (Deionized water is an excellent source of high resistivity water.)

b) This type of rinsing is extremely effective in preventing spots and stains on parts in a final rinse before drying. Chemical rinse aids are another means of achieving spot-free drying. These agents eliminate staining due to water hardness. Some additives also impart a hydrophobic surface on parts in a way to shed water, thus accelerating spot-free rinsing.



Ion exchange water softening.

The advantage of filter cartridges …
In-line filter cartridges or pre-coat filters can be installed to remove very fine particulates from rinse waters. A combination of carbon and cloth filter media can also remove contaminant films such as oils and grease. An added benefit – preventing spray and fog nozzles from clogging.

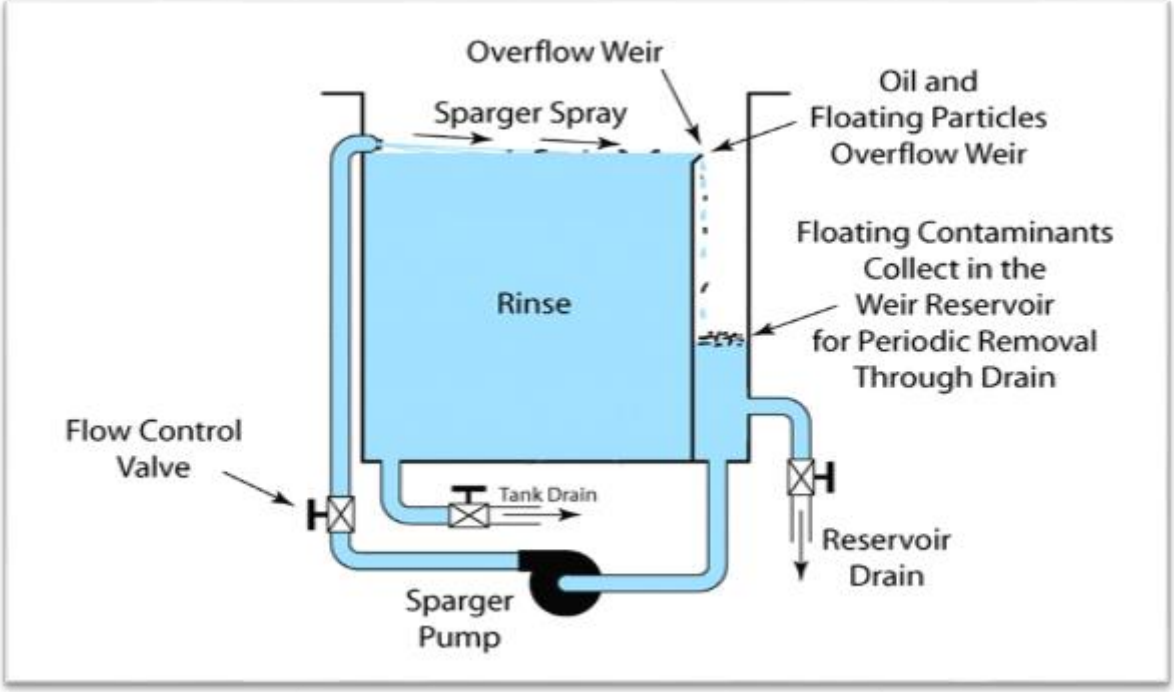
Filter Cartridges for Polishing Rinse Water

9. **Aerators and flow restrictors conserve water – a lot of water.**
   a) Reducing water flow while increasing rinse water agitation, these two devices work hard to realize significant savings.
   b) The aerator is a flow regulator, reducing water flow by mixing air from the incoming source by as much as 50%. A flow restrictor regulates the quantity of water entering the rinse tank and supports in tank movement and turbulence.
   c) Less water to waste treatment offers another direct cost savings. Consider: With a 50% reduction in water on a monthly basis, the estimated savings are approximately $4,000 each month, based on 100 units (where each unit is approximately 2,900 liters / cubic foot).

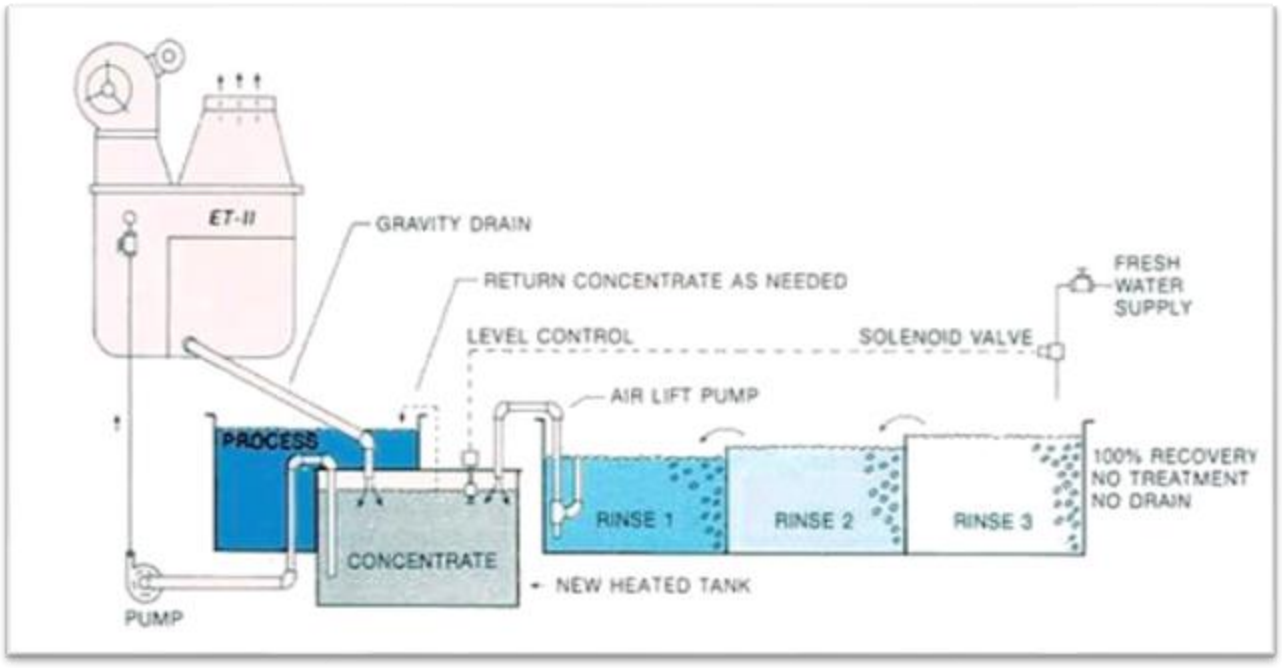
Rinse Water Flow Restrictors

Rinse Water Aerator

10. **Rinses should not hold nor collect surface films.**
    a) Obviously, the purpose of rinsing is to remove films (a.k.a., contaminants) rather than re-depositing them on parts. A rinse tank introduces water at the bottom and – with sufficient turbulence – overflows along the entire tank length, referred to as a dam overflow.
    b) Critical design parameters of the rinse tank include: size of dam trough, outlet size, and water flow. This is where effective skimming occurs. The continuous flow rate is set per specific processing requirements.
    c) Parts enter the multiple rinse tanks in specific stages. As discussed, the preferred rinsing dynamic is a triple counter flow immediately following the stagnant drag-out tank.
    d) The following diagrams illustrate a single rinse tank followed by a process tank and accompanying rinses.



Rinse Tank Views



Process Tank Followed by Triple Counter Flow Rinse

11. **Quality rinsing is positively affected by higher water temperature.**
    a) With changing seasons, some geographical areas encounter chilly or cold winter periods. Incoming city or well water may enter a plant below 40 degF (4 degC). Films such as cleaner drag out (e.g. silicates, caustic soda) and plating drag-out (nickel, copper, chrome, zinc, etc.) are more difficult to remove in cold water.
    b) Rinsing improves as water temperature rises to a distinct limit. The suggested range for rinse water is 75-85 degF (24-29 degC). In certain instances, warmth is provided by heat from adjacent process tanks (such as cleaners, plating, black oxide, electroless nickel).

Keep the heat on.
Two metal finishing processes requiring special attention are hot black oxide and electropolishing, viscous process solutions. Especially in winter, it is not uncommon to encounter plating deposit hazes and adhesion problems related to cold rinses.

12. **Dried films are more difficult to remove than wet.**
    a) The temperature of process baths, such as cleaners, may detrimentally affect quality rinsing. Consider dry-on staining, where water rapidly evaporates leaving dried-on films on the parts. Proper operating temperature range of the process bath (such as cleaning) and concentration, effective for the process operation, should be confirmed in advance.

Contributing to quality rinsing dept.

Barrel plating lines

To optimize barrel utility:

- Balance the load size for sufficient current draw, solution flow-through and drainage. Perforated barrel holes should contain the parts yet allow for solution drainage.
- Repair or replace plugged barrel-plating holes, invariably a chronic maintenance problem.
- During immersion, barrels should continually rotate at a speed equal to that in the plating or previous process tank. Upon exiting any tank, it is recommended to program 2-4 barrel rotations (or as required) above the tank to facilitate drainage.

Plating racks

Optimally engineered plating racks:

- Incorporate proper racking for the finishing operation and permit proper solution drainage
- Reduce solution drag-out loss, which itself would burden rinsing -Encourage solutions to flow downward, courtesy of gravity. Parts should drain until most of the dripping ceases.

Tanks

Rinse tanks should be constructed of materials designed to hold drag-in process solutions without any attack on the tank base material. For many applications, polypropylene, CPVC, or fiberglass is sufficient. Counter flow rinse tanks are typically supplied as compartmentalized units.

Examples of Two Types of Rinse Tanks

Some critical items to consider with regards to rinse optimization:

- Are measures in place to extend service life of rinse tanks?
- If sprays are used, it is important to optimize location and operation
- Effective use of skimmers and agitation
- Incorporate counter flow with flow restrictors and controls
- How is rinse water monitored for quality?

Quality rinsing leads to quality finishing

The challenge is to maximize the application with equipment, tank designs, and line placement in a way that prioritizes quality while also conserving water to minimize consumption and discharge.

The best practices as we've outlined them represent steps toward attaining that goal.
With the myriad of specialized metal finishing specifications (Mil Spec, ASTM, etc.…) coupled with advances in quality control, operating guidelines such as ISO and NADCAP are placing increasing emphasis on optimizing process cycles. Rinsing, as a quality procedure, is integral to meeting and exceeding our expectations in metal finishing. Well worth the effort, it is a driving force in maximizing water conservation by minimizing water consumption. Our industry demands no less.

Our People. Your Problem Solvers.

For more information on this process,
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