WHITE PAPER

The Importance of Rinsing in Metal Finishing Operations

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The focus or driving force of rinsing is to eliminate contaminants from the surface. Below are the rinsing topics covered in this white paper:

- Introduction To Rinsing
- Rinsing Techniques
- Barrel Plating Optimization
- Proper Rinse Tank Procedure
- Contaminant Removal
- Cleaning
- Conclusion

Introduction To Rinsing

Rinsing as a dynamic operation refers to the diluting and subsequent removal of surface films and contaminants. The focus or driving force is to eliminate contaminants from the surface to the extent these are no longer of detrimental consequence. It is an extremely critical portion of any metal finishing process. Yet, rinsing can readily be neglected, rendered ineffective, or minimized. The result of which can spell the difference between satisfactory, quality compliant finishes and rejects. There have been many problems traced back to poor rinsing resulting in contaminating down line process baths.

Proper rinsing basically provides a medium to wash the surface, be it base metal or after specific cycle treatments, thereby conditioning and preparing for the next process or completion. There may be more rinse tanks in a given cycle than process tanks. Some critical rinsing factors to consider are: water purity, agitation, how much for how long and how warm. Water has become an expensive commodity. Its use and availability has become restricted in some geographical areas.

Therefore, the process of rinsing takes on a unique application of maximizing system lay out, selection of effective support equipment, and incorporation in the given process cycle. Quality, efficient, or streamlined rinsing promotes rapid removal of contaminants from surfaces while enabling a reduction in water use. The advantages to the finisher include: meeting the requirements and specifications of quality approved finishes, conservation of water and cost savings of water, less demand on the waste treatment system, minimize rejects, steady and uninterrupted process line operation.

Rinsing Techniques

The following basic facts support the benefits of improved rinsing techniques:

- A **drag out**, or static rinse. It is also termed a reclaim tank. This step immediately follows any treatment or conditioning tank, such as surface preparation, plating or post finishing treatment. The drag out is very important to return carry over solution back to the previous stank. It provides two important benefits: conservation and reclaim of process solution (chemical cost savings) and minimizing contamination of any following rinse tanks.
- **Two rinses are better than one.** The benefits of counter flow rinsing. Time spent in two rinses as part of a double counter flow is more effective than the same time spent in a single rinse.

  Three rinses are better than two. Triple counter flow (or current) rinsing has the effect of two or three standing separate rinse tanks, with the water consumption of one rinse tank. 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. It does so in a direction opposite to the movement of parts. The benefit is least contaminated (freshest water) contacts and conditions the

50%

In this regard, the rinsing efficiency can be improved by 10-20 times and more, while reducing water consumption by more than 50%.

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most thoroughly rinsed parts. Consequently, the most contaminated water contacts and conditions non rinsed parts.

Using a triple counter flow set up can reduce fresh water requirement by as much as 70-80%. Rinse tanks #2 & #3 may provide a dilution range of 30 to 40:1. Use of the counter flow rinse system can reclaim over 75% of metal drag our back to a plating bath. Counter flow rinsing is especially effective to remove films in post alkaline plating cycles. Counter flow rinsing is perhaps the best suited process for combining water conservation with quality parts rinsing. An accompanying benefit is using the discharge water, if capacity permits, as make up for a heated processing tank in a similar application to return of drag out tank solution.

- **Agitation** is beneficial. This is a most beneficial method to rinse parts by using all of the tank's rinse water. Agitation strength should avoid pushing fresh water out the over flow dam before it has been in contact with parts. Movement of water in close proximity to parts affords fresher water contact which is complimented by mechanical action to dislodge contaminant films and any solid particles. Agitation by air or educator is suggested. Although air agitation is good, an educator can be more effective. Agitation of the rinse also helps where water flow is low or lower than desired. On this subject, there are advantages to ultrasonic rinsing as well. The cavitation action which generates scrubbing gas bubbles provides very good mechanical action, scrubbing the surface.
- **Spray rinses** can be very effective. Mechanical energy or velocity of the spray can facilitate the rapid removal of surface films. This occurs with an added benefit of greatly reducing water use. The downside to spray rinsing would be 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 be activated as racked parts exit above the tank, working as an initial rinse. Or, racked parts can be set into a first, empty drag out tank and sprayed before introduction into immersion rinses.
- **Fog nozzles** are both effective and great water savers. They are specifically geared towards rack operations, especially heated process tanks, such as 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. The fog nozzles are another excellent pre rinse treatment prior to immersion in water rinses.

- **Rinse tank** controllers provide cost savings while providing the desired volume of fresh water. The tank controller is an electrical conductivity measuring device that, when calibrated and set, maintains a desired level of predetermined fresh rinse water in the tank. The conductivity of water increases with increased loading of dissolved salts. At a level of these contaminants, per the specific application, adverse rinsing occurs. The tank controller, which is a conductivity probe, is preset to activate a fresh water inlet, lowering conductivity to the predetermined setting. The controller automatically maintains a preferred rinse water quality.
- **Aerators and flow restrictors** are two devices that provide water conservation resulting in cost savings. The method of application is to reduce water flow while increasing rinse water agitation.
- **Rinses should not hold or collect surface films.** The purpose of rinsing is to remove films (contaminants), not to redeposit them on parts. A rinse tank introduces water at the bottom and is allowed, with sufficient turbulence, to overflow along the entire tank length, referred to as a dam overflow. 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 the specific processing requirements.
- Quality rinsing is affected by **water temperature**. Rinsing improves as water temperature rises to a distinct limit. In some instances, warmth is provided by heat from adjacent process tanks (such as cleaners, plating, black oxide, electroless nickel). Cleaner drag out and films from other processes are more difficult to remove in cold water. With changing seasons, some geographical areas encounter

75°-85°F

The suggested water temperature range for rinse water (24°-29°C) chilly or cold winter periods. Incoming city or well water may enter the 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. Two metal finishing processes especially require attention to rinsing in this regard. These are hot black oxide and electropolishing, which are in themselves quite viscous process solutions. It is not uncommon to encounter plating deposit hazes and adhesion problems, related to cold rinses, especially in the winter season.

- **Dried films are more difficult to remove than wet films**. The temperature of process baths, such as cleaners, may detrimentally affect quality rinsing. An example is 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, as long as effective for the process operation, should be confirmed.

Barrel Plating Optimization

With the proper implementation, there are direct process related factors that can, with correct application, contribute to quality rinsing. Barrel plating lines are known for drag out solution losses and the consequences of poor rinsing.

Factors that optimize barrel utility include:

- Balance the load size for sufficient current draw, solution flow thru, and, and drainage. Perforated barrel holes should contain the parts, yet allow solution drainage.
- Repair or replace plugged barrel plating holes. This happens to be an acute maintenance problem.
- During immersion in rinses, 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 in order to facilitate drainage.

Optimally engineered plating racks incorporate proper racking for the finishing operation and permit proper solution drainage. Good racking also reduces solution drag out loss, which itself would burden rinsing. Gravity encourages solutions to flow downward. Parts should drain until most of the dripping ceases.

Proper Rinse Tank Procedure

Rinse tank volume levels should be kept at the proper depth. This avoids parts not being adequately rinsed, or not rinsed at all. Some of the adverse conditions that can be observed include: water discoloration, cloudiness, floating oil & grease residues, and foaming. The desired water level should be maintained, preferably using an automatic inlet valve. 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. Ion exchange is a method by which water is "polished" and can be very beneficial to rinsing. Dissolved metallic ions are removed in a resin bed, purifying the rinse water. This keeps it less contaminated, as it can also be reused by running it through the deionizer system. Deionized water is an excellent source of high resistivity water. This type of rinsing is very good to prevent spots and stains on parts in a final rinse before drying. Chemical rinse aids are another means to achieve spot free drying. These agents eliminate staining due to water hardness. Some additives also impart a hygroscopic surface on parts in a way to shed water, thus accelerate drying spot free.

Contaminant Removal

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 medias can also remove contaminant films such as oils and grease. An added benefit is to prevent spray and fog nozzles from clogging.

Cleaning

Liquid concentrate products, such as cleaners, promote improved rinsing of parts exiting the cleaner tank. This is due to the absence of ingredients in the liquid cleaner that are required in powder formulations for mixing and stability of the blend. Some cleaner formulations provide dual soak and electrocleaning functions. This can be accomplished in one tank, or two separate tanks eliminating the need for a rinse tank in between. Cleaning is mentioned as it has been noted that a significant number of plating and finishing rejects are associated with improper cleaning and poor rinsing.

Conclusion

Rinsing challenges us to use water efficiently, yet in a conservative way. It is a step in which quite simply, the focus or objective is to sufficiently remove the contaminants from a surface by dilution. Rinse tanks only require water. The challenge is how to maximize the application with equipment, tank designs, and line placement. However, this must be accomplished in a manner to conserve water, thus minimizing its consumption and discharge. The basic facts as described previously, singly, and in various combinations, can achieve the goal of quality rinsing, which leads to quality finishing. There are many specialized metal finishing specifications (Mil Spec, ASTM, etc.) that require the end product to meet requirements. With the advances in quality control, operating guidelines such as ISO and NADCAP place the emphasis on optimizing process cycles. Rinsing, as a quality procedure, is integral to meet and even exceed metal finishing expectations. Our industry demands no less.

Contact Steve Rudy today for all of your rinse procedure questions:
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