Water Efficiency

Industry Specific Processes

Metal Finishing

During the past 15 years, the metal finishing industry has made great strides in reducing water use. In a 1994 survey by the National Association of Metal Finishers, 68 percent of respondents had made substantial reductions in water use through pollution prevention techniques. On average, these shops had reduced water flow by 30 percent or about 20,000 gpd. Even with these achievements, metal finishing businesses still continue to have significant opportunities to further reduce water use. Water efficiency within an integrated pollution prevention program can provide these advantages for metal finishers:

- Lower operation cost by reducing water bill.
- Reducing wastewater treatment costs.
- Potentially improving pollutant removal efficiency in wastewater treatment.
- Reducing or delaying need for treatment capacity expansion.

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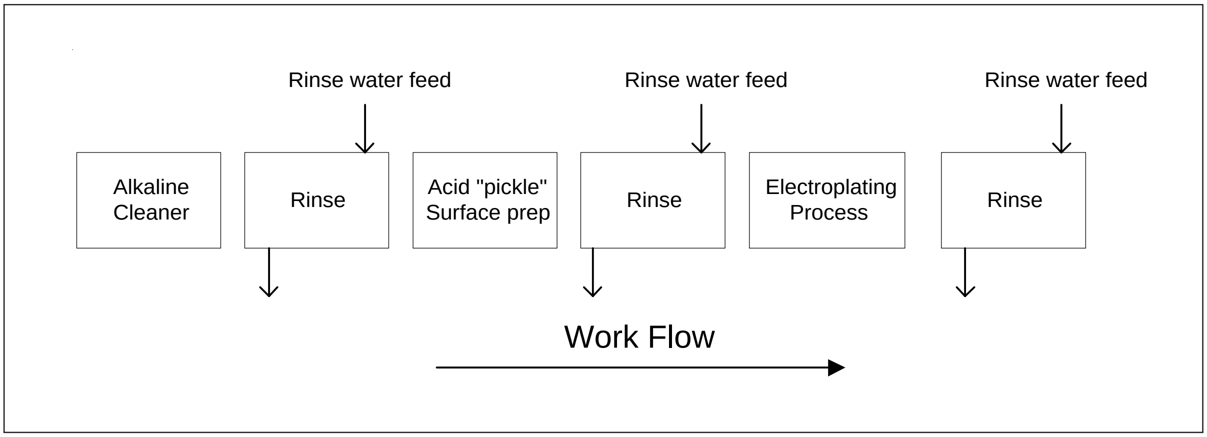


Improving rinsing efficiency represents the greatest water reduction option for metal finishers. A rinsing efficiency program also is the first step to enable metal finishers to implement progressive pollution prevention techniques, such as chemical recovery from the more concentrated waste stream and the potential of closed-looping the electroplating process.

Improving Rinse Water Efficiency

In the metal finishing industry, rinsing quality has a dramatic effect on product quality. Improvements in rinsing efficiency must be carefully integrated into quality control and assurance programs. Rinsing efficiency improvement techniques for metal finishers include improved rinse tank design, flow control techniques and alternate rinse tank configurations *(see Figure 5-11)*.

Rinse Tank Design

Proper design of rinse tanks will improve rinsing efficiency and reduce water use. Optimum rinse tank designs provide fast removal of chemical solutions or “drag-out” from the parts. These techniques can enhance rinse tank design:

- Provide agitation to the tank by air blowers (not compressed air), mechanical mixing or pumping/filtration systems.
- Prevent feed water short-circuiting by properly placing inlets and outlets on opposite ends of the tank.
- Use inlet flow baffle, diffusers, distributors or spray heads.
- Select the minimum sized tank appropriate for all parts/products.
- Consider spray rinsing instead of immersion for flat-surfaced parts.
- Consider ultrasonic rinsing applications where applicable.

Flow Control Techniques

Flow Restrictors

The use of flow restrictors is a very effective means to ensure excessive water is not fed to the process line. Flow restrictors are installed in the feed line of a tank. They are commonly elastomer washers with an orifice that is squeezed smaller with increasing line pressure. They are available in rates ranging from 0.1 gpm to greater than 10 gpm. The flow rate of a restrictor should be chosen to provide sufficient water for quality rinsing. Restrictors work best in consistent production applications.

Flow Cut-off Valves (Manual and Automatic)

Water flow to rinse tanks should be shut off when the process lines are not in use. This can be done manually or automatically. A foot-actuated feed valve can be used in job shops that have discontinuous processing demands. The rinse water valves can be activated only when components are being rinsed. For larger continuous operations, solenoid valves can turn off rinse water lines when power to the electroplating line is turned off. For automatic conveyorized lines, photosensors also can be used to turn on water valves or spray heads only when parts are passing that rinse stage.

Conductivity Meters and Controllers

The most accurate way to control rinse water flows and purity can be achieved using conductivity controls. The use of conductivity meters and control valves will substantially reduce rinse water flow and ensure a set water purity standard is always being met in the tank. Electrical conductivity increases as the concentration of contaminant ions increases.

Conductivity meters indicate the concentration of contaminant ions in the rinse water in units of micromhos (μmhos), also referred to as microsiemens. Specific conductance can be roughly correlated to total dissolved solids in mg/L using empirical data.

Many metal finishing facilities have installed conductivity controllers on the rinse tanks that trigger the introduction of fresh water only when the conductivity reaches a certain set point. This practice significantly reduces water consumption, typically by 40 percent.

CASE STUDY

Conductivity Controller

Artistic Planting and Metal Finishing in Anaheim, Calif., installed electrodeless conductivity controllers on nine rinsing tank systems. Artistic Plating is saving 55,000 gallons per week, which equates to a 43 percent rinse water savings. The conductivity system resulted in decreased rinse water use, wastewater generation, wastewater treatment chemical use and sludge generation. Artistic Plating experienced no adverse quality effects using the controller. Total system payback was one year.

Figure 5-11

Survey Rinse Water Efficiency Applications

Technique	Percent of business using technique[1]	Success rating[2]
Flow restrictors	70	4.1
Countercurrent rinse	68	4.2
Manually turn off rinse water when not in use	66	3.6
Air agitated rinse tanks	58	3.7
Spray rinses	39	3.8
Reactive or cascade rinsing	24	3.8
Conductivity controllers	16	3.3
Flow meter or accumulator	12	3.7
Timer rinse controls	11	3.25

[1]Based on NCMS/NAMF study in 1994--318 metal finishers responding.
[2]Success rating based on scale of one to five, with five bing the highest

Conductivity rinse water flow controllers are most useful on discontinuous electroplating operations. The cost of installing each rinse water conductivity controller will be between $1,000 and $2,000 and typically will have an economic payback of about one year. In the past, conductivity controllers required high maintenance to prevent fouling of electrodes. Newer inductive loop or electrodeless sensors are less susceptible to fouling than conventional electrode types. Determining the optimum set point for these controllers also is imperative to conserve water and maintain quality. Figure 5-12 can be used as a starting point for determining acceptable rinse water purity standards.

Portable conductivity meters also can be used to establish a fixed flow rate to maintain an appropriate rinse water quality. Once rinse water purity levels are established, permanent flow restrictor valves can be installed in the water supply line to the individual rinse tanks. This technique is suggested only where electroplating production is consistent. Again, use Figure 5-12 as a starting point.

Figure 5-12

Acceptable Rinse Water Contaminant Limits

Rinse bath for	Conductivity in micromhos (μmho)
Alkaline cleaner	1,700
Hydrochloric acid	5,000
Sulfuric acid	4,000
Tin acid	500
Tin alkaline	70-340
Gold cyanide	260-1,300
Nickel acid	640
Zinc acid	630
Zinc cyanide	280-1,390
Chromic acid	450-2,250

Flow Meters

Relatively inexpensive meters or accumulators can be installed on the main water feed line, process line or on individual rinse tanks. While meters and accumulators do not actually save water, they do allow for careful monitoring of usage and can identify optimum water utilization (or excessive waste), leaks and system failures.

Alternative Rinsing Configurations

Countercurrent Rinsing

Countercurrent rinsing is the practice of overflowing rinse water between a series of rinse tanks so that the water flow is in the opposite direction to work flow. This results in the final rinse being the cleanest. Countercurrent rinsing significantly reduces water usage without sacrificing rinsing efficiency. A common configuration for a countercurrent rinse is two to three rinse tanks in series. Water consumption can be reduced more than 90 percent just by adding a second counterflowing rinse to a single rinse tank. *(See Figure 5-13.)*

If floor space is a problem, a partition could be installed in the existing rinse tank with a metal divider acting as a weir. This modification can be made only if there is sufficient room for the parts rack or barrel in the tank.

Reactive Rinses and Reuse

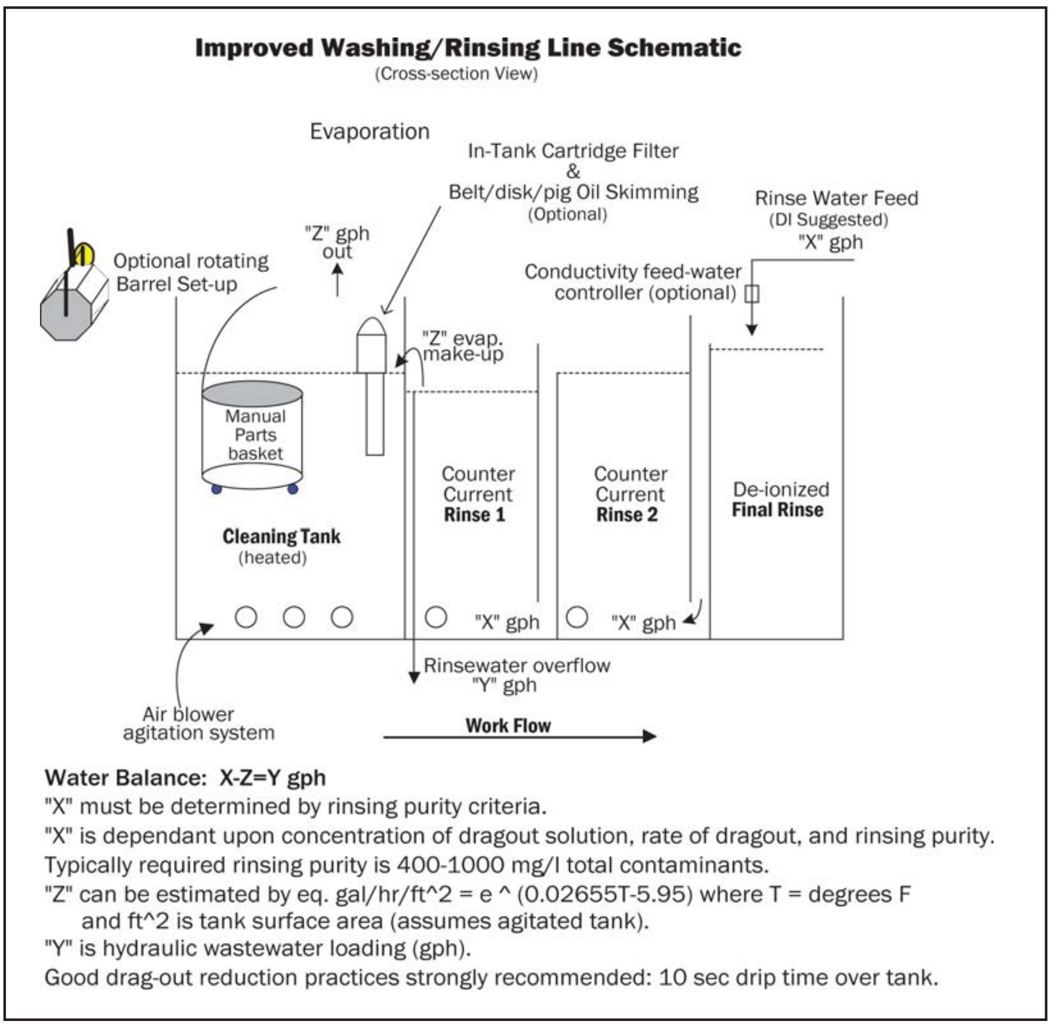
A reactive rinsing system involves diverting the overflow from an acid rinse to an alkaline rinse tank. *(See Figure 5-14.)* The acid ions neutralize the alkaline ions without causing contamination of the rinse water or compromising plating quality. By reusing acid rinse baths for alkaline cleaner rinses, the effectiveness of the alkaline cleaner rinses can be improved while reducing water consumption by 50 percent. Furthermore, the rinse water from single rinse stages following plating baths has been shown to effectively clean products in rinses following acid or alkaline cleaning without affecting the rinse effectiveness. Rinse water sometimes can be reused from a critical rinse to a less critical rinse in the same processing line or between processing lines. Care should always be taken to ensure cross contamination is not problematic.

Spray Rinsing

Spray rinsing can be incorporated into existing metal finishing process lines to further reduce water use. Typically, spray rinses can be used directly over heated process tanks or over a dead rinse to reduce drag-out. By spraying drag-out back into its process tank or into a concentrated holding tank, less water will be needed for final rinsing.

Spray nozzles for these applications typically have flow rates ranging from .04 to 1.0 gpm. Nozzles can be hydraulic nozzles, which spray water only, or air-atomized nozzles, which use compressed air. Nozzle spray patterns are available in full cone, hollow cone, flat fan and finer misting and fogging types. Spray angle and length of spray pattern is important when specifying the number and spacing of nozzles. Components of spray systems include a water supply, filter, switch, check valve and nozzle(s). The approximate installed cost for a spray system over an existing tank is less than $2,000. Case studies have shown these systems are paid for in less than one year in water and chemical savings.

Figure 5-13



Reducing Drag-Out to Improve Rinsing

The term "drag-out" refers the residual solution that still is adhering to a part when it leaves a process bath. The drag-out is the solution that must be rinsed off the part. By employing techniques that reduce the volume of drag-out, metal finishers can rinse parts using less water. Potential drag-out reduction techniques for metal finishers include:

- Operating bath formulations at minimum chemical concentrations.
- Maximizing bath operating temperature to lower bath viscosity.
- Using wetting agents to reduce surface tension. Up to a 50 percent drag-out reduction can be achieved.
- Racking parts to maximize drainage. Drag-out rates for very poorly drained parts are three to 12 times the rates for well-drained parts with vertical, horizontal and cup-shaped surfaces.
- Extending drainage time over process tank or dead rinse tank.
- Increasing drip time from three to 10 seconds reduces the drag-out remaining on a part by an average of 40 percent.
- Using spray or fog rinsing over the process tank or dead rinse tank
- Positioning drainage boards between the process tank and next rinse tank.

CASE STUDY

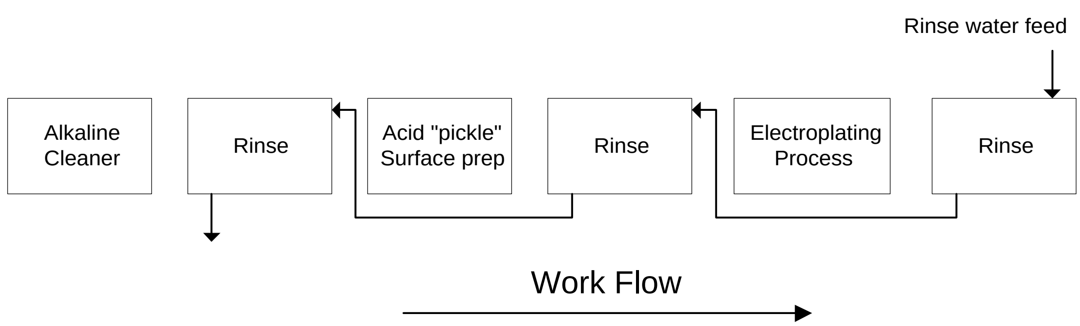
Rinsing Efficiency

C & R Hard Chrome & Electrolysis Nickel Service Inc. in Gastonia reconstructed its electrolysis nickel line to incorporate several pollution prevention techniques and improve processing efficiency. Single-rinse tanks were switched to a system of multiple counterflow rinse tanks to reduce water consumption. Restrictive flow nozzles on water inlets were added to better control and reduce water consumption. The process line upgrades reduced water consumption by 87 percent, from 7,500 gallons to less than 1,000 gallons per day.

By reducing the volume of process solutions carried out of the plating tank, metal finishers can reduce rinse water, conserve expensive bath formulations and directly reduce the pollutant mass loading to wastewater.

Figure 5-14

Rinse Water Reuse and Reactive Rinsing



Wastewater Reuse Techniques

Some electroplating shops are reusing treated wastewater for non-critical rinsing steps such as after alkaline cleaners and acid pickling steps. The reuse of conventionally treated wastewater (via hydroxide precipitation) should be cautioned due to the introduction of high dissolved solids into the plating line. Drag-out and drag-in from conventionally treated water can contaminate other process baths with contaminants such as sodium. In conjunction with advanced membrane separation techniques such as reverse osmosis, wastewater reuse becomes more feasible from an operations standpoint. Some companies have successfully closed-looped electroplating rinse tanks by employing continual cationic and anionic exchange reclamation of metals.

An electro-coagulation/ultraviolet process patented by Pasco Inc., has been successfully applied to treat and reuse alkaline and acid rinse waters and bath dumps. The process offers cost effective high quality water reuse and low sludge generation due to no needed chemical additions for solids coagulation and flocculation treatment stages.

Other novel applications of wastewater treatment techniques such as electro-coagulation and absorptive/adsorptive media hold promise to enable electroplaters to close loop their operations.

N.C. Division of Pollution Prevention and Environmental Assistance
POLLUTION PREVENTION PAY$

The North Carolina Division of Pollution Prevention and Environmental Assistance provides free, non-regulatory technical assistance and education on methods to eliminate, reduce, or recycle wastes before they become pollutants or require disposal. Telephone DPPEA at (919) 715-6500 or (800) 763-0136 for assistance with issues in this fact sheet or any of your waste reduction concerns.

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