# Reducing Dragout With Spray Rinses

The Merit Partnership is a joint venture between U.S. Environmental Protection Agency (EPA) Region 9, state and local regulatory agencies, private sector industries, and community representatives. The partnership was created to promote pollution prevention (P2), identify P2 technology needs, and accelerate P2 technology transfer within various industries in southern California. One of these industries is metal finishing, which is represented in the Merit Partnership by the Metal Finishing Association of Southern California (MFASC). Together, MFASC, EPA Region 9, and the California Manufacturing Technology Center (CMTC) established the Merit Partnership P2 Project for Metal Finishers. This project involves implementing P2 techniques and technologies at metal finishing facilities in southern California and documenting and sharing results. Technical support for this project is provided by Tetra Tech EM Inc. (formerly PRC Environmental Mangement, Inc.). The project is funded by the Environmental Technology Initiative and EPA Region 9 and is implemented, in part, through CMTC by the National Institute of Standards and Technology.

This fact sheet summarizes the benefits of installing spray rinses on electroplating lines, including reduced dragout and better rinsing; the components of spray rinses; and some considerations for designing them. In addition, this fact sheet describes a spray rinse case study conducted at a decorative nickel and chrome electroplating facility in southern California.

## WHY USE SPRAY RINSES?

Using spray nozzles as part of a rinse system can significantly reduce (1) dragout of expensive and hazardous process chemicals and (2) the amount of rinse water needed. When used on parts over plating and dragout tanks, spray rinses provide a method to recover concentrated process chemicals for reuse. By reducing dragout, spray rinses allow immersion-type rinse tanks to operate at lower flow rates or even as static rinses. Also, spray rinses use rinse water more efficiently than stagnant and running rinses. Spray rinse applications in electroplating lines (both hand-operated and automatic conveyer and hoist systems) include use over plating tanks, dragout tanks, and rinse tanks. The ideal spray rinse application permits dragout reduction and reuse and improves rinse performance.

**Benefits of Spray Rinses**

- Less raw material wasted because of reduced dragout
- Less contamination of process baths by dragin
- Lower rinse water flow rates required in running rinses
- More efficient, higher quality rinsing

Installing well designed spray rinses can have an immediate and significant effect on your bottom line.

## CONES, FANS, AND MISTS

Nozzles are the key components of spray rinses and are commercially available with a wide range of flow rates and several spray patterns. Common suppliers of nozzles are manufacturers of industrial nozzles and suppliers of plumbing and irrigation equipment. For applications over plating and dragout tanks where minimizing flow rate is critical, nozzles with flow rates ranging from 0.04 to 1.0 gallon per minute (gpm) are used in groups to provide coverage and are operated intermittently to minimize water use. Nozzles with flow rates ranging from 1.0 to 10 gpm are typically used for applications where minimizing flow rate is not so critical. The two types of nozzles

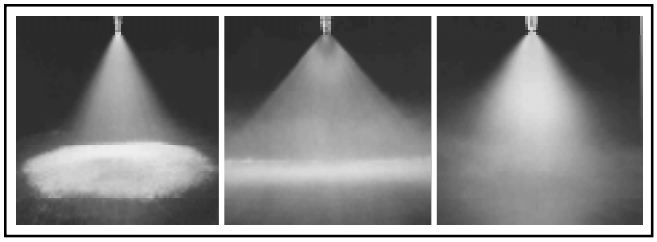

**Figure 1. Cone, Fan, and Fine Sprays**

available are hydraulic nozzles, which spray water only, and air-atomized nozzles, which use both water and air. Available nozzle spray patterns include full cone, hollow cone, flat fan, and fine spray like mists and fogs. Hydraulic spray rinses with full cone, flat fan, and fine spray patterns (see Figure 1) are adequate for most applications on electroplating lines. Air-atomized nozzles can be used where compressed air is avail-

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### Determining Net Flow Rate of Spray Rinses Over Plating Tanks

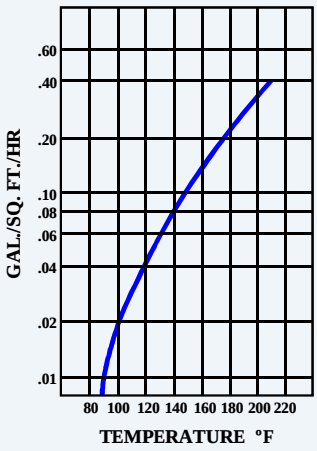
To avoid overflow of plating tanks, the net flow rate of the spray rinses should not exceed the evaporation rate of the plating solution.

*Net Flow Rate < Evaporation Rate*

*Net Flow Rate = (No. of nozzles) • (nozzle flow rate) • ( % of time nozzle sprays)*

***Evaporation Rate:*** Various plating handbooks provide graphs and tables for evaporation rates as a function of temperature. However, direct measurement of evaporation rate by recording volume of make up water added or the increase in freeboard over time is preferable.

Source: Electroplating Engineering Handbook, Durney, 1984




able to increase the rinsing effectiveness of the spray by generating a mist or fog. Other nozzle specifications important to designing spray rinses are the angle and length of the spray pattern, which determine the number and spacing of the nozzles. Specifying a nozzle spray angle can help to achieve complete coverage or overlapping patterns from adjacent nozzles.

## DESIGN CONSIDERATIONS FOR SPRAY RINSES

Components for spray rinses include filters, switches (electrical or mechanical) to turn the nozzles on and off, and check valves (see Figure 2).

***Filters:*** Rust and dirt particles from aging metal supply lines can prevent check valves from opening and sealing properly and can cause nozzle spray patterns to deteriorate. Adding a filter to the water supply line is necessary to prevent clogging of the small orifices in check valves and nozzles.

### Pick the Best Switches for the Application

**Lever**: Mechanically switched on and off by passing equipment such as hoists, conveyors, and racks; well suited to automated lines

**Pressure Contact:** A plastic-coated, pressure-sensitive strip switch that can be used on hang bars; good for racks manually placed on a hang bar over plating and dragout tanks

**Trigger**: Hand-held spray gun with trigger; allows focused rinsing

**Foot Pedal**: Installed with sprays on hand-racked lines; ideal for brief rinses over a dragout tank while operator holds racks

***Switches:*** Switches (operated manually or with timers) can be used to shut off flow when spray rinses are not needed. Using switches ensures that the resulting rinse solution is low in volume, is highly concentrated, and is therefore easier to return to the plating tank.

***Check Valves:*** In spray rinses with nozzles that operate intermittently or on a timer, check valves offer two distinct advantages: (1) they prevent water in the supply line from draining into the tank when the switch closes, and (2) they maintain line pressure so that the spray pattern develops quickly when the water is turned on. These advantages are significant for spray rinses installed over plating tanks and for stagnant rinse tanks where overflow is a possibility.

### Tips for Check Valves

- Buy check valves that allow adjustment of nozzle actuating pressure
- Use one check valve per nozzle
- Place check valve close to nozzle

## CASE STUDY: ALL AMERICAN SPRAY RINSES

The Merit Partnership sponsored a P2 project that involved installing and evaluating spray rinses at the All American Manufacturing (All American) facility in Los Angeles, California. The All American facility performs job shop and captive shop work, including both metal stamping and forming operations, and it electroplates decorative nickel and chrome onto plumbing fixtures. The facility covers about 20,000 square feet, of which 5,000 square feet is dedicated to metal finishing. All

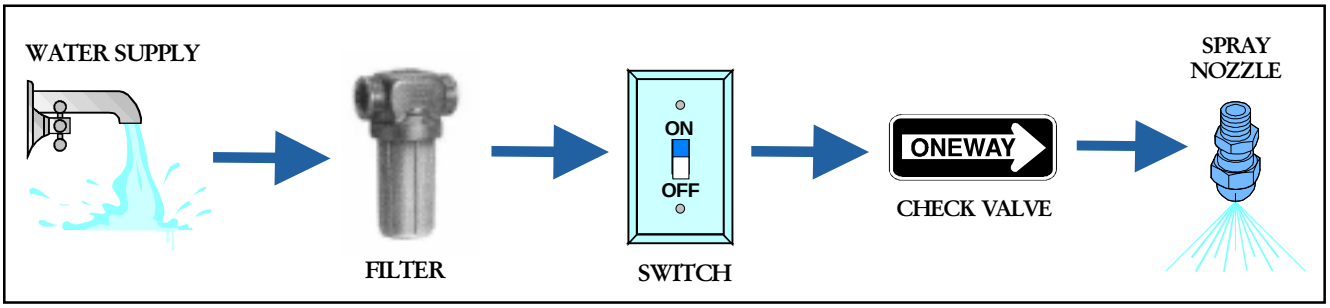



**Figure 2. Components of Spray Rinses**

**Three Spray Rinse Applications at All American**

| | Nickel Plating Tanks (2) | Nickel Dragout Tanks (2) | Chrome Plating Tank |
|---|---|---|---|
| Nozzles/Tank | 8 | 8 | 6 |
| Nozzle Spray Pattern | Flat Fan (Hydraulic) | Flat Fan (Air-Atomized) | Misting (Hydraulic) |
| Nozzle Material | Stainless Steel | Brass | Plastic |
| Flow Rate/Nozzle | 0.3 gpm | 0.4 gpm | 0.04 gpm |
| Net Flow Rate/Tank | 0.12 gpm (8 nozzles at 0.3 gpm for 3 seconds per minute) | 0.27 gpm (8 nozzles at 0.4 gpm for 5 seconds per minute) | 0.12 gpm (6 nozzles at 0.04 gpm for 30 seconds per minute) |

American employs about 10 workers in the electroplating department for one shift per day. The plating line consists of two parallel nickel plating lines with an automated hoist followed by a single chrome plating line that is first hand- and then conveyor-operated. The rinse system for each line originally consisted of an immersion-type dragout tank and a series of stagnant and running rinse tanks. The primary objective of the P2 project for All American was to reduce dragout loss and enhance dragout recovery by adding several spray rinses to the existing rinse systems. By first reducing dragout, All American can reduce water use and consider chemical recovery technologies that move the operation toward its goal of zero discharge.

Three spray rinses are installed at the facility: one over a pair of nickel plating tanks, one over a pair of empty nickel dragout tanks, and one over the chrome plating tank. Nozzle material is selected based on the corrosiveness of each installation. An adjustable check valve is installed immediately upstream of each nozzle to prevent draining of water and to maintain line pressure. The net flow rate from the spray rinses over the nickel plating tanks is selected so as not to exceed the evaporation rate of the tanks and to minimize evaporator use before dragout is returned to the plating tanks.

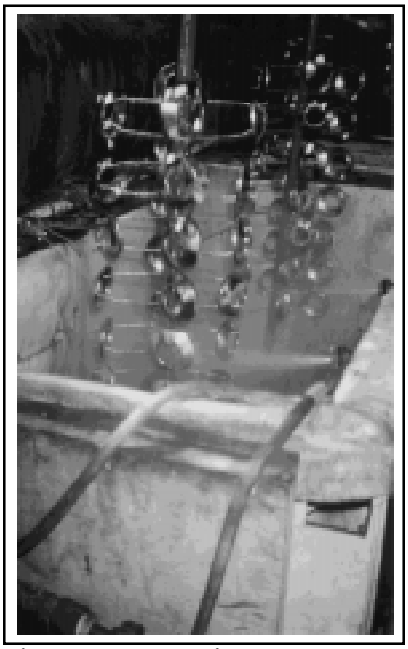


**Figure 3. Spray Rinses on Nickel Dragout Tank**

***Nickel Plating Line Spray Rinses:*** Both spray rinses on the nickel plating lines are actuated by switches tripped by the up-and-down movement of the hoist. Each tank has eight nozzles mounted around the lip of the tank and directed slightly downward so that the combined dragout and rinse water drop into the tanks and overspray is minimized. The spray rinses on each tank turn on separately once per cycle: the spray rinses over the plating tanks turn on as the racks are withdrawn from the tanks, and the spray rinse over the nickel dragout tanks (see Figure 3) turns on as the racks are lowered into the tanks.

***Chrome Plating Tank Spray Rinse:*** Six fine spray misting nozzles are installed above a hang bar over the chrome plating tank (see Figure 4); one nozzle is used for each rack position on the hang bar. A compressed air vibrator is also attached to the hang bar in order to enhance droplet formation. The nozzles are angled about 45 degrees toward the splash guard at the rear of the tank. The nozzles are actuated by two pressure-sensitive contact switches installed along the top of the hang bar. Each switch controls three nozzles and is actuated by the weight of the racks on the hang bar.

***Operation and Maintenance:*** Maintenance of the spray rinses includes periodically removing the nozzles from the nozzle bodies and washing away any obstructions from the nozzle interiors with water or compressed air. The filters used at All American are canister-type filters with no filter elements and need to be periodically unscrewed and rinsed. Before the filters were installed, many of the check valves became clogged and did not open and shut quickly and completely. With the filters in place, these problems have not recurred.

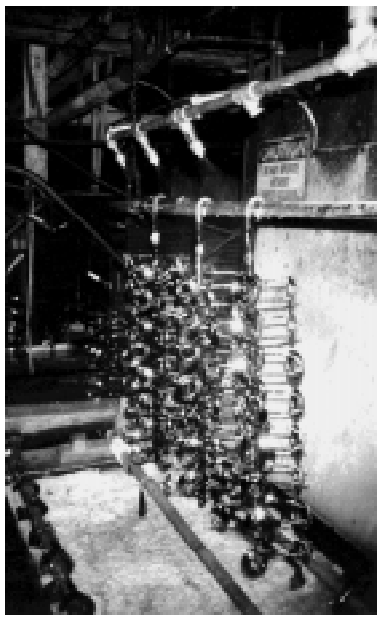


**Figure 4. Misting Nozzles over Chrome Plating Tank**

## CASE STUDY COSTS

The total cost for all three spray rinse applications was $4,890. In-

| All American Spray Rinse Costs | |
|---|---|
| Nozzles | |
| Two Nickel Plating Tanks | $800 |
| Two Nickel Dragout Tanks | 480 |
| Chrome Plating Tank | 60 |
| Check Valves | 100 |
| Piping | 650 |
| Pressure Reducers and Filters | 600 |
| Switches | 600 |
| Installation | 1,600 |
| **Total** | **$4,890** |

stallation of the spray rinses was performed by All American staff, and operation and maintenance are performed as part of the staff's daily inspection routine.

Nozzle costs vary widely (from $2 to $70 per nozzle) depending on the material used and the supplier. Generally, industrial spray nozzle manufacturers provide higher quality at a higher cost and offer nozzles made of a variety of materials with precise spray patterns and flow rates; plumbing and irrigation equipment suppliers provide less expensive, plastic nozzles and less selection of nozzle operating parameters.

## CASE STUDY RESULTS

After installation of the spray rinses and several weeks of system shakedown and fine tuning, a series of tests were performed under controlled plating and production conditions with and without the three spray rinses operating. As parts were plated, the conductivity (which can be related to the concentration of plating solution) of the rinse water was measured in a stagnant rinse tank immediately following the tanks with spray rinses.

During the tests, the spray rinses over the nickel plating and dragout tanks together reduced dragout from the nickel plating lines by 58 percent compared to dragout from the lines operating with no spray rinses (see Figure 5). The spray rinse over the chrome plating tank reduced dragout by 64 percent compared to the system operating with no spray rinse.

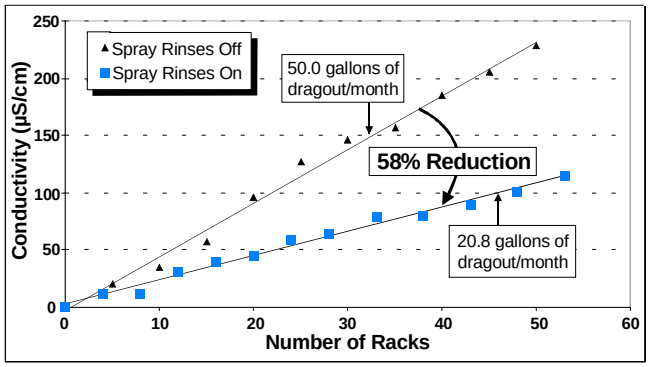



**Figure 5. Sprays Reduce Nickel Dragout by 58%**

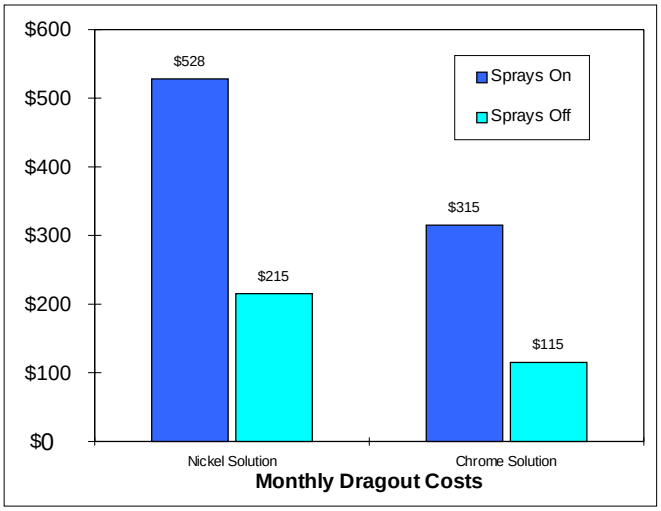



**Figure 6. Monthly Cost Savings Due to Dragout Reduction**

| Spray Rinse Results | | | |
|---|---|---|---|
| | Without Sprays | With Sprays | Monthly Savings |
| Nickel Solution Dragout | 50.0 gal/mo | 20.8 gal/mo | $313 |
| Chrome Solution Dragout | 63.1 gal/mo | 23.0 gal/mo | $200 |
| Rinse Water* | 380,000 gal/mo | 152,600 gal/mo | $185 |

**Total Cost Savings = $8,376/year**
**Total Cost = $4,890**
**Payback Period = 0.6 year**

* Estimated based on dragout reduction

Data from the tests demonstrate that the addition of the spray rinses to the existing rinsing scheme at the All American facility dramatically reduced the dragout from both the nickel and chrome plating lines (see Figure 6). Based on the savings associated with recovery and reuse of the nickel and chrome plating solutions and the corresponding rinse water reduction possible, the payback period for the rinses installed is 0.6 year. Although All American does not treat its wastewater before discharge, facilities performing on-site treatment would experience additional savings of the treatment chemical, sludge disposal, and operating costs associated with treatment systems. Industry average costs for treatment of wastewater from electroplating operations are about $12 per 1,000 gallons.

**For more information on spray rinses, the Merit Partnership, or the All American case study, please contact the following individuals:**


| | | |
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