DRAFT

Electroplating Tip Sheet

Drag-Out Reduction

Electroplating Tip Sheet Series
1. Good Operating Practices
2. ***Drag-Out Reduction***
3. Rinse Water Reduction
4. Recovery and Recycling of Bath Chemicals

Background

A common practice in the electroplating industry is the dipping of parts to clean, neutralize, and plate them combined with several intermediate rinsing stages. This tip sheet provides general suggestions on how to reduce pollution caused by the drag-out of solutions from tank to tank and to decrease the generation of wastewater. The use of any one of the below suggestions can help to prevent pollution, but the implementation of a combination of suggestions can significantly increase waste reduction. It is up to each facility to determine what combination of suggestions will work best for them, being sure to weigh all advantages against disadvantages. For a detailed schematic of a typical electroplating process without pollution prevention control methods, see Appendix A.

In the electroplating industry, drag-out refers to the solution remaining on products, racks, and barrels as the products and these suspension systems are moved from various process baths and water rinsing operations. This solution (drag-out) can flow back into the process tank, can be rinsed off, and does evaporate. The residual drag-out on products will show up in the next tank as drag-in. An electroplating operation is generally intolerant of the contamination of drag-out from a previous process. Thus, the general practice is to perform rinsing between processes. Because used rinse water is usually a major waste stream from electroplating facilities, it is environmentally and economically desirable to minimize rinse water. Drag out reduction will reduce the need for treatment and disposal or recovery of rinse water. A successful approach to this is to minimize the amount of drag-out remaining on the products they are removed from a process tank.

The total drag-out remaining on the product is the major factor in determining the amount of rinse water needed. If drag-out can be reduced, then the total rinse water can be reduced. The drag-out quantity is affected by a number of factors:

- The chemical concentration in the process bath
- Viscosity
- Surface tension
- Part design
- Rack or barrel design
- Speed of withdrawal

Appendix B is experimental data that provides insight into the range and variables of drag-out quantity that will be experienced in production.

Drag-Out Reduction

There are many proven practices that will significantly reduce the amount of drag-out. Incorporation of an appropriate combination of these will decrease environmental concerns and operating costs through pollution prevention, with no compromise in product quality, process time, or electroplating functions. Some attractive options are:

1. Rack Design: A rack is needed to suspend the products when they are immersed in the chemical baths. The rack design is made to suspend parts for quick draining, including vertical flat surfaces, diagonal suspension of square surfaces, holes with drainage paths, part indentations or "cups" suspended to provide drainage, and no top rows of parts draining onto lower rows. Rack materials should be chosen with a smooth surface (less surface tension, such as stainless steel), a material that will survive all the chemicals in all the process baths without corrosion or chemical deterioration, and a coating, if coatings are used, that will survive the production environment of repeated impact and chemicals. Loose or damaged coatings provide excellent places for drag-out to collect.

2. Barrel Design: A barrel will retain at least 10 times more drag-out than most racks. However, where products consist of many small parts, there may be no other reasonable choice. Significant barrel design considerations include: a construction material that will not degrade, deteriorate, or add unwanted chemicals and metals to the process; an arrangement with as large open surface area as possible (many big holes); and a design that can be readily cleaned to remove cumulative build-up. Some automatic handling systems have a feature that will ensure the barrel is suspended door side up during withdrawal from a bath so that the barrel door does not trap drag-out.

3. Bath Chemical Concentration: Some facilities have discovered that the chemical concentration in a given process bath can be successfully operated at considerably lower concentration levels than that recommended by the manufacturer. A 25% reduction in chemical concentration will generally result in more than a 25% reduction in rinse water requirement at the following rinse stage. In practice, a concentration reduction of up to 50% of the manufacturer's recommendation has not resulted in product quality degradation.

4. Bath Temperature: An increase in bath temperature will result in a lower viscosity and reduce the total drag-out. However, a higher temperature will increase the evaporation rate, energy costs, and contaminate level.

5. Wetting Agents: In some cases, it has been possible and desirable to introduce wetting agents into the process bath. A wetting agent should reduce the chemical surface tension, provide improved drainage, and reduce drag-out. Because of the

number of different chemicals used in the electroplating industry, further consideration of this suggestion is beyond the scope of this tip sheet, and would best be discussed with a chemical supplier and manufacturer.

6. Slower Workpiece Removal: The slower a loaded rack or barrel is removed from the process bath, the thinner the remaining film on the workpiece, and the less the drag-out. This effect is so significant that most of the time allowed for withdrawal and drainage of a rack or barrel should be used for withdrawal only.

7. Extended Drip Time: The rack or barrel should be suspended over the process tank, from which it is withdrawn, for a significant interval. A suspension for 15 seconds may reduce the drag-out by as much as 50%. In general, it is strongly recommended that a minimum of 10 seconds be allowed. Depending on rack and part geomtries, more than 30 seconds will not significantly further improve drag-out reduction. For manually operated hoist systems, the drain interval control can be aided through the installation of a timer to give the operator a positive indication of the drain interval. For barrel operations, remember, “Door side up!”

8. Agitate Over Bath: During the time the workpiece is suspended above the tank from which it has just been removed, rotation or some form of agitation will assist drainage. A simple turning or twisting of the rack may be needed to empty recessed areas. A mechanical agitator or a jerking motion of the rack will accelerate drainage.

9. Spray Rinse Above Process Tank: A spray rinse installed above the process tank can be a very effective method for reducing drag-out (See Figure 1). In addition, the spray water can be used to compensate for evaporative losses from the process tank and ensure that much of the drag-out returns to its proper place in the process tank. In cases where the spray rinse eliminates the need for a subsequent rinse bath, the rinse waste consumption rate will be reduced to zero, because all rinse water is returned to the process bath rather than becoming waste. In cases where spray rinse cannot replace all of the subsequent rinse baths, it will provide a significant reduction in drag-out added to the rinse baths, resulting in a significant reduction in water usage. Note that the spray water source must use water conditioned in the manner similar to the water used in the process bath. In the design of a top spray system, it is most desirable to confine the spray water. A high velocity spray always has a tendency to blow away. This spray will include the process bath chemicals, which are usually corrosive, hazardous, and toxic in both the liquid and vapor forms. Inadvertent release of spray into the local area may result in worker safety or compliance issue.

DRAFT

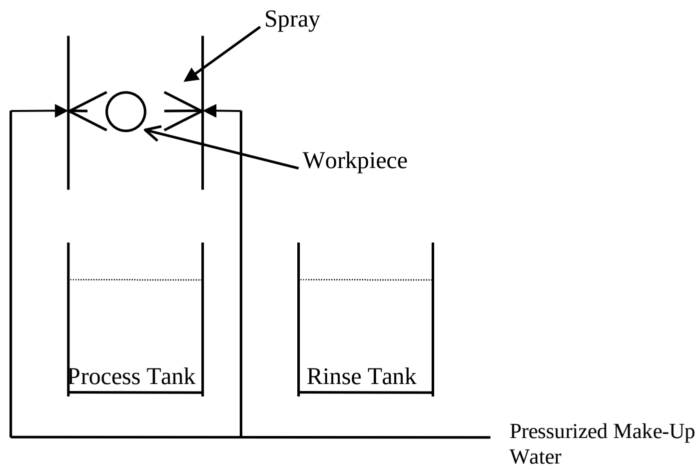


Figure 1
Schematic of Spray Rinse Above Process Tank

10. Drain Boards: Drain boards are a simple and effective means to recover drag-out and prevent drag-out spills in the area between tanks (See Figure 2). Spilled drag-out may lead to release of hazardous chemicals into the general occupied area, the ground or the storm water system. The drain boards consist of simple flat surfaces, installed between tanks and tipped toward the process tank for drainage. The drain board will catch all drag-out drainage during part movement from tank to tank.

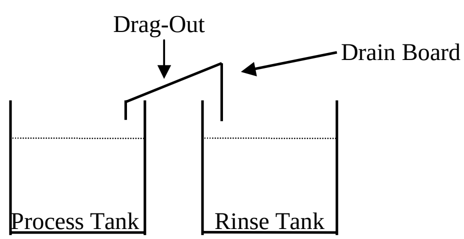


Figure 2
Use of Drain Board for Drag-Out Recovery

11. Drain Pans: In cases where the production process can not use the rack movement system for an extended drain time, it may be desirable to install an additional tank in the process line. This tank will be used under the rack or barrel to catch and accumulate drag-out (See Figure 3). The accumulated drag-out is subsequently returned to the source process tank to partially offset its losses.

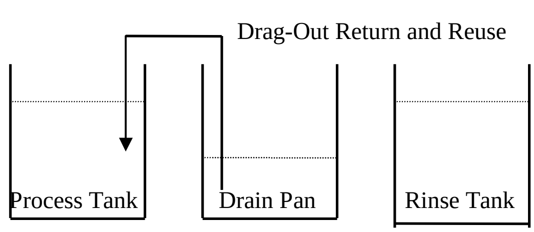


Figure 3
Use of a Drain Pan for Drag-Out Recovery and Reuse

12. Static Drag-Out Rinse Tank: Many facilities employ a static rinse tank to collect the drag-out and provide for a reduced water usage in the subsequent rinse tanks (See Figure 4). This is a tank located immediately downstream from the process tank and just ahead of the rinse tank(s). The tank is filled with water conditioned in accordance with the water used in the process tank. There is no continuing inflow of water. The contents of this tank are used to make up the losses in the associated process tank. The static tank is generally a more efficient drag-out remover than the empty drain tank above, and is an effective method to recover otherwise expended chemicals. Like the drain pan in the previous section, the static drain tank will allow the movement system to perform other tasks while this rack is draining, but will require another tank in the line. Some facilities have found it desirable to insert the rack into this static drag-out tank both prior to and subsequent to immersion in the process bath.

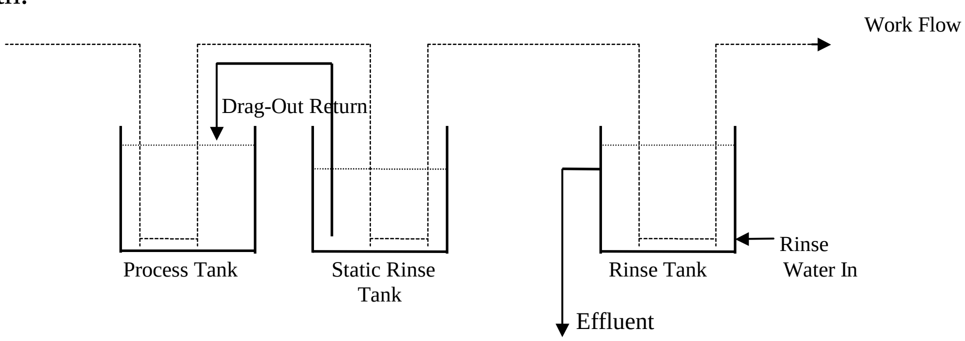
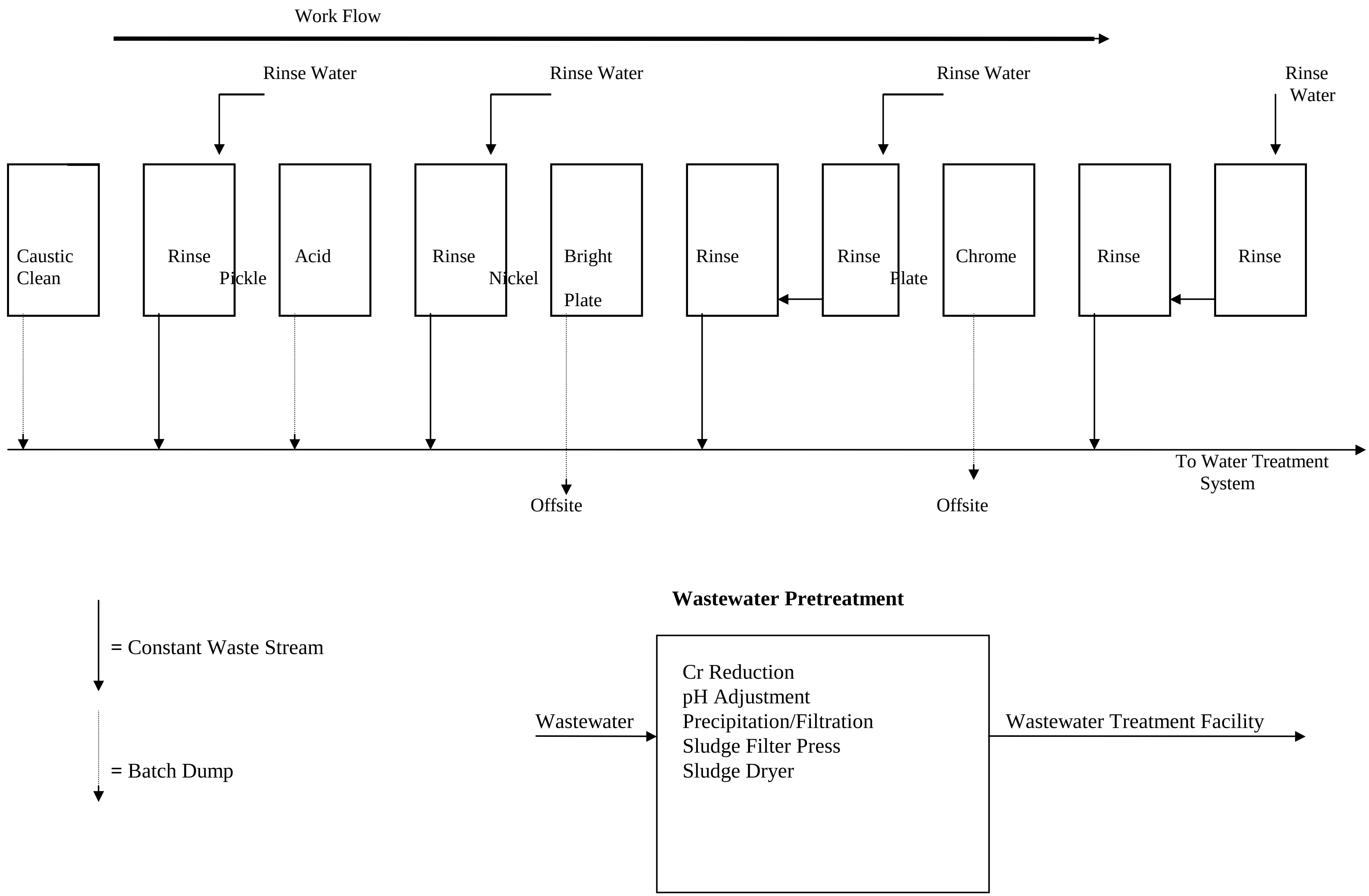


Figure 4
Use of a Static Rinse Tank for Drag-Out Recovery and Reuse

13. Chemical Recovery and Reuse: Where drag-out collection tanks are used, (as described in paragraphs 11 and 12 above) it is good practice to return that drag-out to replenish the chemicals in the tank, to compensate for normal losses. This practice will reduce the waste disposal requirements of the drag-out and reduce the cost of chemicals. If the total drag-out rate, spray rate, or static bath accumulation rates exceed the evaporation loss from the process tank, then it is a good practice to use an evaporator to reduce the volume of solution recovered. Evaporators range from a simply heated open surface tanks to commercial units that employ a pump to move the solution, a blower to move the air, a heat source, an evaporation chamber in which the solution and the air can be mixed, and a mist eliminator to remove any entrained liquid from the exit air stream.

DRAFT

Appendix A
Schematic of a Typical Electroplating Line
Without Any Pollution Prevention Control Methods



DRAFT

Appendix B
Some Experimental Data on Drag-out Rates

A. Average Drag-Out Losses (Soderberg**)

Nature of Work Drainage	Drag-Out Rate (gal/1000 ft²)
VERTICAL	
Well drained	0.4
Poorly drained	2.0
Very poorly drained	4.0
HORIZONTAL	
Well drained	0.8
Very poorly drained	10.0
CUP SHAPES	
Well drained	8.0
Very poorly drained	24.0

B. Drag-Out Amounts Based Upon Hogaboom's** Work

	Drag-Out Rate (gal/1000 ft²)	
Solution Type	Flat Surfaces	Contoured Surfaces
Brass	0.95	3.3
Cadmium	1.00	3.1
Chromium (33 oz/gal)	1.18	3.0
Chromium (53 oz/gal)	4.53	11.9*
Copper Cyanide	0.91	3.2
Watts Nickel	1.00	3.8
Silver	1.20	3.2
Stannate Tin	0.83	1.6
Acid Zinc	1.30	3.5
Cyanide Zinc	1.20	3.8

* It is of interest to note the effect of increased viscosity. A 60% increase in concentration level results in an increase of 296% in drag-out volume.

** WRATT Training: Electroplating Session, North Carolina Office of Waste Reduction