Metal Finishing P2 Checklist: Progressive Green Chemistry

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P2 Program Overview

- In 2016, LA Industry (LAI) team launched P2 Advocacy program in Los Angeles
- Sector-Specific Data Drive Public Education and Outreach
- 8 Sector Champion Teams Continues to Support LA's Industries
- LASAN Regulates 89 Facilities with Metal Finishing Operations
- Utilize P2 Checklist Assessments to Recommend Pollution Prevention Practices to Businesses

Successful Pathway

- Assess P2 Performance
- Evaluate and Optimize Checklist
- Peer Review and Support from National P2
- Green Score/Report Card
- Incorporate Sector Specific P2 Measures into Green Business Certification Program
- Education & Outreach
- Analyze Industry Trend on P2/GC technology
- Analyze Legislative Impact on the Sector
- Advocate for Financial Incentives or Grants

P2 Checklist Elements

Process Substitution

- Material Substitution
- Pollution Prevention Equipment and Systems
- Best Housekeeping Practices
- Emission Reductions
- Solid Resources Recovery
- Wastewater and Stormwater Management
- Water Conservation
- Controls and Technology

Change of one or more processes resulting in higher efficiency; reduces volume and or toxicity of waste generated.

- Reduce dragout losses
- Extend drip process for chemical plating solution to minimize dragout
- Control or prevent introduction of contaminants into process plating solutions
- Ensure rack of work-pieces plated with cavities open downward, not racked directly over one another; improves plating solution drainage
- Install automated process line system for more precise monitoring and transfer operations
- Install drain boards, drip bars and air knives
- Adjust process schedules or dedicate process equipment when processing parts
- Lower the concentration of the plating bath constituents and increase the temperature of the plating solution
- Filter plating solutions to minimize contamination
- Sandblast or pre-clean parts mechanically to reduce use of toxic acids
- Use non-chlorophenolic biocides and non-hex chrome chemicals to maintain cooling towers
- Conduct regular testing to maintain plating tanks to operate at peak performance (in this case, ultrasonic level sensors)
- Remove dropped parts from process tanks on a daily basis

Reduce Dragout Losses

Metal Finishing "Process Unit"



Extend drip process for chemical plating solution to minimize dragout



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Filter plating solutions to minimize contamination



Sandblast or pre-clean parts mechanically to reduce use of toxic acids



Use non-chlorophenolic biocides and non-hex chrome chemicals to maintain cooling towers



Conduct regular testing to maintain plating tanks to operate at peak performance (in this case, ultrasonic level sensors)



Remove dropped parts from process tanks on a daily basis



Changing raw materials in a production process to more sustainable materials, resulting in source reduction where less pollutants are generated in any environmental medium, air, water or land

- Use water-based cleaners and non-halogenated solvents to clean parts
- Replace cyanide with non-cyanide plating solution
- Use purified/distilled/deionized water
- Use trivalent chromium instead of hexavalent chromium in the plating process
- Use greener chemistries in chemical conversion coating
- ► Use neutral washing agents
- Replace solvent degreasing with alkaline degreaser, use wetting agents (surfactants) to reduce solution surface tension
- Use aqueous carbonate-based chemical developers in printed circuit board (PCB) manufacturing
- Switch to terpene in place of Trichloroethylene (TCE) or Dichloromethane (DCM)
- Substitute acetone cleaners with ethyl acetate
- Substitute chelating agents with non-chelated process chemicals
- Reduce heavy metal usage by substitution with less toxic and more sustainable materials for the

Use water-based cleaners and nonhalogenated solvents to clean parts



Replace cyanide with non-cyanide plating solution



Use purified/distilled/deionized water



Use trivalent chromium instead of hexavalent chromium in the plating process

"The Beauty"

"The Beast"



Chromium Sulfate-based Trivalent Black Chromium

Chromium Trioxide-based Hexavalent Black Chromium

Use greener chemistries in chemical conversion coating



Use neutral washing agents



Replace solvent degreasing with alkaline degreaser, use wetting agents (surfactants) to reduce solution surface tension



Use aqueous carbonate-based chemical developers in printed circuit board (PCB) manufacturing



Switch to terpene in place of Trichloroethylene (TCE) or Dichloromethane (DCM)



Substitute acetone cleaners with ethyl acetate



Substitute chelating agents with non-chelated process chemicals

Reduce heavy metal usage by substitution with less toxic and more sustainable materials for the manufacturing of PCBs

Chelates Can't Live With 'em, Can't Do Without 'em

An agent that will form a compound with a heavy metal ion, with the intended purpose of keeping the metal in solution.

Highly Desired in Plating Solutions

A Big Problem in Wastewater Treatment



Install source control pollution prevention systems that reduce pollutant loading and improve regulatory compliance

- ▶ Use alternative treatment technologies to reduce the generation of sludge (filter cake)
- Replace lead-lined tanks or lead anodes bags
- Replace hazardous metal pipe with PVC pipe
- ▶ Use refrigerated freeboard chillers (as secondary condenser) on vapor degreasing units
- Prevent accidental bath overflows of process tanks by installing automated water restriction devices
- Install closed-loop plating systems
- Reduce generation of unnecessary metal sludge

Use alternative treatment technologies to reduce the generation of sludge (filter cake)



Replace lead-lined tanks or lead anodes bags



Replace hazardous metal pipe with PVC pipe

Use refrigerated freeboard chillers (as secondary condenser) on vapor degreasing units





Prevent accidental bath overflows of process tanks by installing automated water restriction devices Install closed-loop plating systems (Hard chrome shown)

Reduce generation of unnecessary metal sludge







Implement and improve general operating procedures and preventive measures

- Cleaning, repairing, and maintaining racks and tanks to prevent bath contamination
- Repairing leaking tanks, pumps and valves
- Checking daily for leaking tanks or pipes
- Preventing foreign materials from entering/remaining in process tanks to prolong the life of a bath
- Proper labeling of process tanks, equipment and materials
- Repair bare concrete and secondary containment subject to chemical spillage in order to prevent chemical release
- Implementation of an Environmental Management System (EMS)

Cleaning, repairing, and maintaining racks and tanks to prevent bath contamination



Repairing leaking tanks, pumps and valves



Checking daily for leaking tanks or pipes



Preventing foreign materials from entering/remaining in process tanks to prolong the life of a bath



Proper labeling of process tanks, equipment and materials



Repair bare concrete and secondary containment subject to chemical spillage in order to prevent chemical release



Implementation of an Environmental Management System (EMS)



Reduce operational tank & material fugitive emissions with chromium, nickel, cadmium, lead or copper in powder or metal salt form

- Use of "negative" air pressure (flow of ambient air into process area)
- Establish clear tank labeling
- Ensure plating, anodizing or passivation operations are performed in an enclosed space
- Conduct buffing, grinding, and polishing operations within a building enclosure with barrier to prevent dust migration
- Turn off heated plating tanks when not in use
- Cover all heated plating and sealer tanks when not in use
- ▶ Install and maintain splash guards
- Use compressed air to dry parts
- Install drip trays and contain liquid properly
- Implement approved Facility Enclosure Compliance Plan
- Implement SCAQMD BMPs to prevent air emissions

Use of "negative" air pressure (flow of ambient air into process area)

Establish clear tank labeling

Placing Vapor Distribution Systems and Appliances into Operatio

Negative Air Pressure

When the air pressure inside a building is lower than the air pressure outside, air is forced into the building through any opening it can find, including the venting system. If gases are not properly vented from the space, unburned gases, such as carbon monoxide, could remain in the structure. This phenomenon is called "negative air pressure." Negative air pressure occurs in a room or building that cannot supply a sufficient amount of air to meet appliance combustion requirements.

Appliances need the correct ratio of air-to-propane for combustion. This ratio can be disrupted by exhausting air, either by **natural causes or mechanical devices**.





Lesson 1

ORE

Ensure plating, anodizing or passivation operations are performed in an enclosed space

Conduct buffing, grinding, and polishing operations within a building enclosure with barrier to prevent dust migration





Turn off heated plating tanks when not in use

Cover all heated plating and sealer tanks when not in use





Slowly remove parts from the plating baths

Rinse parts with a high pressure, lowtemperature or mist/fog device equipped with fume suppressant or poly balls as an added technology feature



Install and maintain splash guards







Install drip trays and contain liquid properly

Implement approved Facility Enclosure Compliance Plan







Implement SCAQMD BMPs to prevent air emissions (cover process tanks to minimize evaporation/fugitive emissions)



Solid Resource Recovery

Electrowinning



Filter cake recycling to recover precious metals



Solid Resource Recovery

Tramp oil separation



Metals Recycling & Material Exchange



Water Conservation Practices: On-site rinse water recycling, water recovery techniques; recovery of plating constituents; wastewater treatment

- Reuse rinse water to reduce water usage & recover precious metals (e.g. resin plant for precious metal recovery)
- Reverse osmosis for heavy metals recovery
- Reuse of (some) treated wastewater instead of discharge
- Solvent recycling by distillation for subsequent reuse of solvents
- Metals removal from spent plating solution
- Recirculating cooling waters through a cooling tower and other in-process recycling
- Use waste acid and/or alkaline rinses for pH adjustment in wastewater treatment systems
- Segregate the waste stream to eliminate pollutants
- Approved Toxic Organic Management Plan
- ► Install an efficient rectifier

Reuse rinse water to reduce water usage & recover precious metals (e.g. resin plant for precious metal recovery)

Reverse osmosis for heavy metals recovery





Reuse of (some) treated wastewater instead of discharge

Solvent recycling by distillation for subsequent reuse of solvents

Wastewater Reuse in the world





Metals removal from spent plating solution

Recirculating cooling waters through a cooling tower and other in-process recycling

| Method | Advantages | Disadvantages | References | | |
|------------------------------------|---|--|------------|--|--|
| Adsorption | Simple operation Cost effective High quality Reversible process | Disposal problems | [6, 8] | | |
| Ion exchange | Metal selective Fast kinetics High treatment capacity | High cost Low flow rate Elevated | [21] | | |
| Coagulation and flocculation | Simple processNon-metals selective | High cost High consumption of coagulant Excessive production of sludge | [13] | | |
| Chemical precipitation | Simple process High degree selective Inexpensive | Large sludge production Slow metal precipitation | [5] | | |
| Reverse osmosis | Simple operation Can remove bacteria | High pressure | [9] | | |
| Ion floatation | Effective separation method of metal-loaded biomass. Efficient removals, 95% | • - | [11] | | |



Use waste acid and/or alkaline rinses for pH adjustment in wastewater treatment systems



Segregate the waste stream to eliminate pollutants

Approved Toxic Organics Management Plan (TOMP): Toxic Organic Compounds

- TTO Sources
- Disposal Methods
- Spill Prevention Techniques
- Treatment technologies (carbon absorption)
- Employee Training

Approved Toxic Organics Management Plan (TOMP): Pollution Prevention Techniques

- Material Substitution
- Process Modifications
- On-Site Reuse
- Installation of P2 Equipment/Systems
- Product Changes
- Water Conservation

Install an efficient rectifier

Improve water conservation through implementation of rinsing process efficiencies

- Countercurrent rinsing
- Over-/single tank rinsing
- Static (still) rinsing
- Spray or mist rinsing
- Agitation in rinse tanks
- Cascade rinsing

Over-/single tank rinsing

Static (still) rinsing

Spray or mist rinsing

Sprays: More than a Rinse!

Before Dragout 0.25 gph Rinsewater 2 gpm Chromium Bath 130,000 ppm Cre+ 2 2 lbs chrome/day

- Parts moved directly to rinse tank from plating bath
- Dragout rate = 0.25 gph
- Rinse water flow rate = 2 gpm
- Chromium discharge = 2.2 lb/day

- Parts rinsed with mist spray above plating tank
- Dragout rate = 0.13 gph
- Rinse water flow rate = 1 gpm
- Chromium discharge = 1.1 lb/day

Agitation in rinse tanks

Cascade rinsing

Manage and monitor water usage

- Automatic flow controls i.e. flow restrictors and conductivity sensors on rinse tanks
- Timed or automatic shut-off valves
- Alarm systems (pH/ORP)
- Water meters for each production line
- Install eductors

Automatic flow controls (flow restrictors) on rinse tanks.

Automatic flow controls (conductivity sensors) on rinse tanks (measure materials ability to pass an electric current)

Timed or automatic shut-off valves

Alarm systems (pH/ORP)

Water meters for each production line

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Flow Indicator Used when measuring very low flow through the meter.

Meter Dial

Leak Indicator

If no water is being used inside or outside, this indicator should not be moving. If it is rotating, you may have a leak.

Place Holder

Indicated by [0]

Meter Register

Every turn of a number in the first black register measures 10 gallons; the second, 100 gallons.

Every turn of a number in the white register measures 1000 gallons

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