Metal Finishing Workshop
March 4, 2010

Hosted by:
New York State Pollution Prevention Institute at
Rochester Institute of Technology

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Who We Are

• Probably the best kept secret in town
• CIMS (Center for Integrated Manufacturing Studies)
  – NYSP2I
  – Mechanical testing
  – Reverse Engineering
  – Electronic Systems
  – Lean Training
  – Environment, Health, and Safety Training and Assessments
  – Ergonomics lab and training
NYS Pollution Prevention Institute

- Statewide Coverage
- Committed Partnerships
Vision:
The vision of the NYS P2I is to foster the transformation and development of sustainable businesses and organizations in New York State in a collaborative program committed to making the State a leader in environmental stewardship.

Mission:
The mission of the Institute is to provide a high-impact, comprehensive and integrated program of technology research development and diffusion, outreach, training and education aimed at making New York State more sustainable for workers, the public, the environment and the economy through:
• reductions in toxic chemical use
• reductions in emissions to the environment and waste generation
• the efficient use of raw materials, energy and water
# Workshop Agenda:

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:30am - 9:00am</td>
<td>Registration, Coffee &amp; Bagels</td>
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<tr>
<td>9:00am - 9:55am</td>
<td>Dave Fister: Plating line overview, Rinse water reduction techniques</td>
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<tr>
<td>9:55am - 10:05am</td>
<td>Short Break</td>
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<tr>
<td>10:05am - 11:00am</td>
<td>Jim Hankinson: Energy use in the exhaust system</td>
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<tr>
<td>11:00am - 11:55am</td>
<td>Ray Graffia, Jr.: How to save money, improve parts’ cleanliness, reduce waste hauling, &amp; lower chemical usage – by extending the life of your aqueous cleaners</td>
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<tr>
<td>12:00pm - 1:00pm</td>
<td>Lunch</td>
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<tr>
<td>1:00pm - 2:00pm</td>
<td>Facility Tour and Filtration Demonstration (Arbortech)</td>
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<tr>
<td>2:00pm - 2:55pm</td>
<td>Dave Fister: Water use reduction &amp; recovery methods</td>
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<td>Dave Fister: Energy savings in paint &amp; powder coat curing</td>
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<tr>
<td>2:55 pm - 3:05pm</td>
<td>Short Break</td>
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<tr>
<td>3:05pm - 4:00pm and 4:00pm - 4:30pm</td>
<td>Newton Green and Rajiv Ramchandra: Acid bath management and acid life extension Questions and Answers</td>
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</tbody>
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First Morning Session
9:00pm - 9:55pm

Dave Fister:
Metal Finishing 101,
Stepping away from the process
Who Can Benefit

- Powder coaters: parts preparation
- Painters: parts preparation
- Platers
- Chemical conversion, phosphating
- Anodizers

- All have similar process steps: cleaning and rinsing
The Really High Level

• What are we really trying to accomplish?

• Answer: Add some value to parts with some sort of quality coating for the least amount of money.
The Process

Clean, heated air

Clean racks

Energy

Fresh chemicals

Clean water

Dirty parts

Heated exhaust fumes

Coated racks

Spent or contaminated chemicals

Dirty water

$$$, utility bills

Finished parts

$$$

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Next, Treatment

- Waste chemicals need to be treated, $$
- Exhaust fumes may need to be scrubbed (scrubbing water needs to be treated), $$
- Fresh make-up air needs to be heated, $$
- Paint fumes, VOC’s, may need thermal oxidation, $$
- Dirty water may need to be treated, $$
- Treatment sludge needs to be hauled, $$
- Racks need to be stripped, $$
Develop a Baseline

• Water costs: include water purchase cost and water sewer cost (sometimes a tax item)
• Chemical costs: cleaners, acids, plating salts, etc.
• Waste treatment costs: chemicals, labor, sludge disposal, resin regeneration chemicals, etc.
• Ventilation system: blower motor size, natural gas cost or other heating fuel cost
• Electricity cost: pumps, blowers, compressors, hot air dryers, etc.
Rochester Example

- Water use = 6,310,000 gpy = $32,900/yr. ($5.22/1000 gallons)
- Exhaust blower = 10,000 cfm = $7,899/yr. for 40 hours per week ($0.09/kwh)
- Make-up air heating = 431 decatherms = $2,154 /yr. ($5/decatherm)
- Acid purchases (HCl) = $19,700 ($1.25 /gallon, 15,760 gallons)
- Caustic purchases (NaOH) = $6,400 ($2.10/lb, 3,048 lbs.)
- Sludge disposal = $15,600
- Total cost per year = $66,923/year
The Improved Process

Clean, heated air

Clean racks

Energy

Fresh chemicals

Clean water

Dirty parts

$\text{Finished parts}$

Heated exhaust fumes

Coated racks

$, utility bills

Spent or contaminated chemicals

Dirty water
Water Use Reduction: Rinse Water

- Measure the flow rate on each rinse tank to determine the rinse water use
  - Needed: ruler, tape measure, stop watch, small pump and hose
  - Pump the tank down 1-2" inches
  - Measure the time it takes for the water level to move some convenient amount (1/2”, 1”, etc.)
  - Measure the surface area of the tank (length, width)
  - Length x width x change in water level = volume in cubic inches (231 cubic inches = 1 gallon)
  - Gallons/measured time gives the flow rate
Typical Cleaning Steps

1. Alkaline cleaner, could include ultrasonics, agitation, or electrocleaning to assist the cleaning chemistry in contaminant removal. Contaminants are typically oil, dirt, buffing compound, fingerprints, etc.

2. **Rinses** (parts drag alkali into rinse water)

3. Acid etch, to remove light rust or oxides

4. **Rinses** (parts drag acid into rinse water)

5. Sometimes a repeat of the alkaline and acid steps including **rinses**
Purpose of Rinsing

• First rinse tank
  – remove most of the previous tank’s chemicals
  – Stop the chemical reaction from the previous tank

• Second rinse tank
  – Final rinse to remove additional chemicals
  – Minimize contamination of next chemical tank

If there was zero dragout of chemicals then there would be no need to rinse!!!
Typical Cleaning and Rinsing Layout

Parts and solution drag-out movement

Alkaline Electroclean
Alkaline Rinse 1
Alkaline Rinse 2
Acid Dip
Acid Rinse 1
Acid Rinse 2

Water out at 3 gpm
Water in at 3 gpm
Water out at 3 gpm
Water in at 3 gpm
Water out at 3 gpm
Water in at 3 gpm

Water use at 12 gpm

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Optimized Cleaning and Rinsing Layout

Parts and solution drag-out movement

- Alkaline Electroclean
- Alkaline Rinse 1
- Alkaline Rinse 2
- Counterflow Rinse
- Acid Dip
- Acid Rinse 1
- Acid Rinse 2
- Counterflow Rinse

Water use at 3 gpm

Water out at 3 gpm

Water in at 3 gpm

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Monitoring the Rinse

- Rinse water contaminants (chemical solution dragout) are typically electrically conductive in solutions.
- As more solution gets dragged into a rinse tank the rinse conductivity goes up.
- As the rinse flow is increased the contamination level drops more rapidly due to dilution (and vice versa)

Note: Conductivity is directly related to total dissolved solids or TDS
Flow vs. Concentration

• Measuring contamination in rinse water
  – Chemical analysis (slow and expensive)
  – Solution conductivity: start with a beaker, end with on-line rinse tank measurements

Conductivity/TDS meters cost from $140-$900
Simple Rinse Dilution Model

100 gallon tank, .05 gal. dragout, 100 gm/gallon in dragout
Real World Rinse Dilution Model

![Graph showing the concentration over time for different flow rates (0%, 5%, 10%, 15%, 20%, 25%, 30%) with time in minutes on the x-axis and concentration on the y-axis. The flow rates are indicated by different line colors: 5 gpm (blue), 4 gpm (red), 3 gpm (green), 2 gpm (purple), and 1 gpm (pink).]
Immersion Rinse

• Conclusion: Based on the rate of dilution in even a small tank (100 gallons), it is very difficult to obtain good rinsing with a single rinse tank. Even relatively high flow rates of 5 gpm cannot keep up with the contamination loading from parts dragout.

• Therefore, there really needs to be a second rinse tank for critical rinsing.

• And......it becomes very important to determine your real rinse tank dynamics by measuring flow and conductivity/TDS
Flow Controls in Immersion Rinsing

• In-line flow restrictors: the hand operated valve has an aperture to restrict the flow to some maximum value at maximum valve opening.

• Conductivity controls: rinse valve opens and closes based on TDS value of rinse tank.

From: www.freshwatersystems.com

From: Myron L Company, Controlstik Systems
Conductivity/TDS Controls

Finding the best TDS setpoints (valve opens when water reaches maximum TDS setpoint, valve closes when water reaches minimum TDS setpoint)

• Measure the TDS with a meter in the critical rinse tanks. Knowing the existing flow rate also helps.
Immersion vs. Spray Rinsing

3 gpm continuous

100 gallon tank turnover rate is 33 minutes

3 gpm continuous

8 spray nozzles, each running 0.75 gpm total water use per minute is 6 gpm rinse for 2 minutes every 10 minutes

averaged flow, 1.2 gpm
Other tricks with spray rinsing

- If part geometry is difficult to rinse with fixed spray, if the line is a manual line then the operator can use a manual spray rinse to reach the hard-to-rinse areas of the parts.
- If the chemistry is difficult to rinse with cold water, set up an in-line heater for the spray water supply or have a pre-heated supply tank.
Questions?