# Waste Process Optimization

## ECO Finishing

**Jerico Sanchez Hulstrand**

**MnTAP Advisor: Michelle Gage**

**Company Supervisor: Paul Madden**


MnTAP

UNIVERSITY OF MINNESOTA

# Company Overview

- ECO Finishing provides over 20 different types of metal finishes for protection or decoration
- Process parts for aerospace, military, commercial, and automotive industries
- Thirteen process lines with either rack or barrel plating


# Incentives for Change

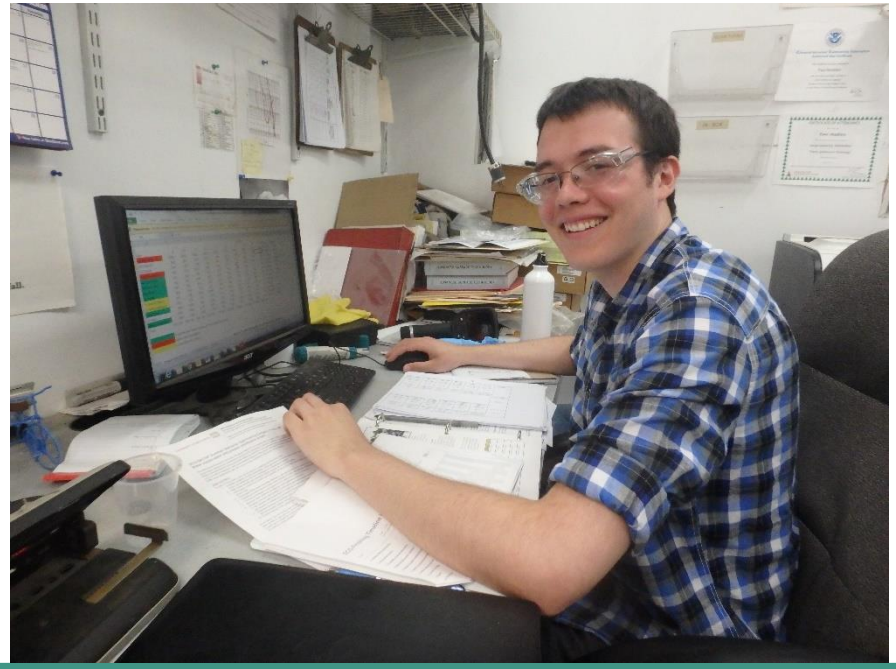
- **Current Situation**
  - 28,000,000 gal/year of water costs $200,000 in purchase and sewer charges
  - Disposal of 840,000 lbs./year sludge costs $120,000
- **Increasing water and waste disposal costs**
- **As company expands, increased water use and sludge generation**


# Reasons for Seeking MnTAP Assistance

- **Waste Stream Optimization**
  - Map continuous and batch wastewater treatment systems
  - Determine feasibility of treating solid waste
  - Research alternate waste treatment chemistries and processes
- **Water Reduction Opportunities**
  - Analyze water consumption
  - Investigate water reuse technologies
  - Reduce water use at the source
- **Make Recommendations**
  - Cost analysis and technical feasibility

# Project Approach

- Map out and understand production and waste processes
- Collect data on waste and water streams
- Research relevant technologies with greatest benefits
- Contact vendors for quotes and information
- Propose and oversee recommendations



# Closed Loop System

- **Water Reuse Potential**
  - Over 60,000 GPD sent to sewer after treatment
  - System with 70% recovery saves 15 million gal/year
- **Ultrafiltration**
  - Low pressure membrane, based on size exclusion
  - Serves as reverse osmosis pretreatment
  - Removes suspended solids (TSS), oils, colloids
- **Reverse Osmosis**
  - Desalination, removes minerals
  - Removes dissolved solids (TDS)

# Closed Loop System (continued)

- **Cost Analysis**
  - Initial estimate provided by Haliant Technologies
  - Operating cost of $47,000 per year includes electrical requirements, labor, and membrane maintenance
  - Reduce future Sewer Availability Charge (SAC)


| Water Savings (gal/year) | Water Savings ($/year) | Capital Cost | Operating and Maintenance ($/year) | Net Savings ($/year) | Payback Period (months) |
|---|---|---|---|---|---|
| 15,000,000 | $110,000 | $130,000 | $47,000 | $63,000 | 25 |

# Barrel Waste Reduction

- **Metal Drums**
  - Barrel waste can include acid waste, sludge, acid or alkaline solutions, carbonate solids
  - Good candidates for evaporation have high water content and little debris, such as electro/soak cleaner
- **55 Gallon Drum Evaporator**
  - Evaporates 2 gal/hour of water
  - Electrically heated system uses drum as disposal vessel
  - Does not require operator while running
  - Mist eliminator system

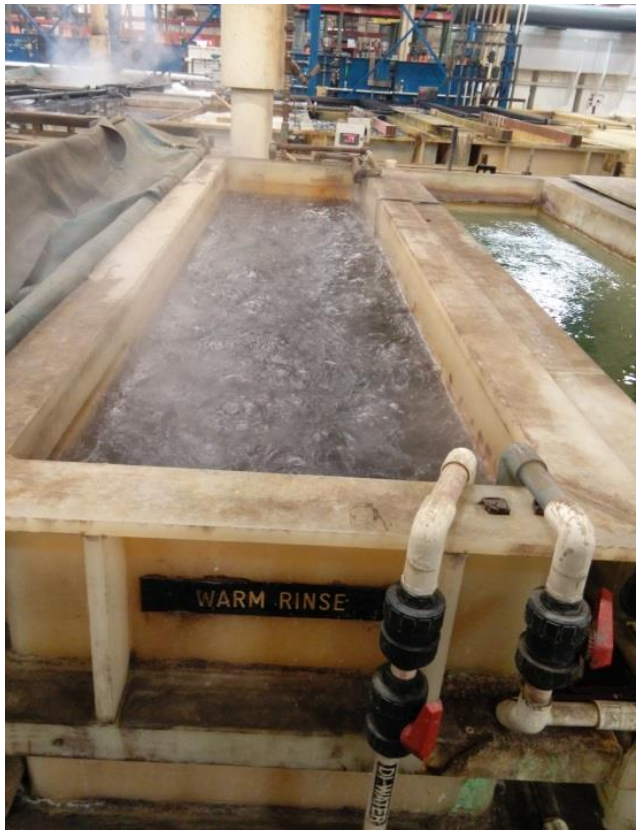
# Barrel Waste Reduction (continued)

- **Cost Analysis**
  - Proposed use for electro/soak cleaner, sludge, waste liquid, which accounts for 32% of barrel waste
  - Estimate of 50% evaporation rate
  - Barrel content determines price, average of $260 each
  - Condenser module for water recover costs an additional $10,000, so not economically feasible

| Waste Reduction (lbs./year) | Waste Reduction ($/year) | Capital Cost | Operating and Maintenance ($/year) | Net Savings ($/year) | Payback Period (months) |
|---|---|---|---|---|---|
| 19,000 | $10,800 | $9,600 | $2,700 | $8,100 | 14 |

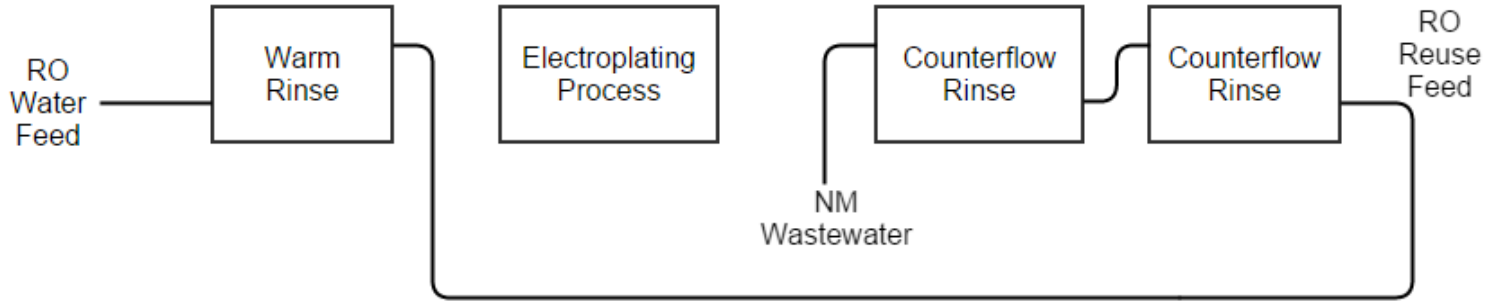
# Reusing RO Rinse Water

- **Water Reclamation**
  - Hot water rinses are clean enough to reuse before treatment
  - One possibility for reuse is pipe to another rinse,  to recover 2,000,000 gal/year
  - Replace city water for a cleaner rinse
  - Decrease volume of water sent to waste treatment
- **Stream Compatibility**
  - Checked for pH, conductivity, waste treatment needs
  - At least one tank in each line eligible for water reuse



# Reusing RO Rinse Water (continued)

- **Rinse Reuse Example**
  - Hand Line Warm Rinse to Counterflow Rinse
  - Cleanest RO rinse, pH near that of city water (6.62)

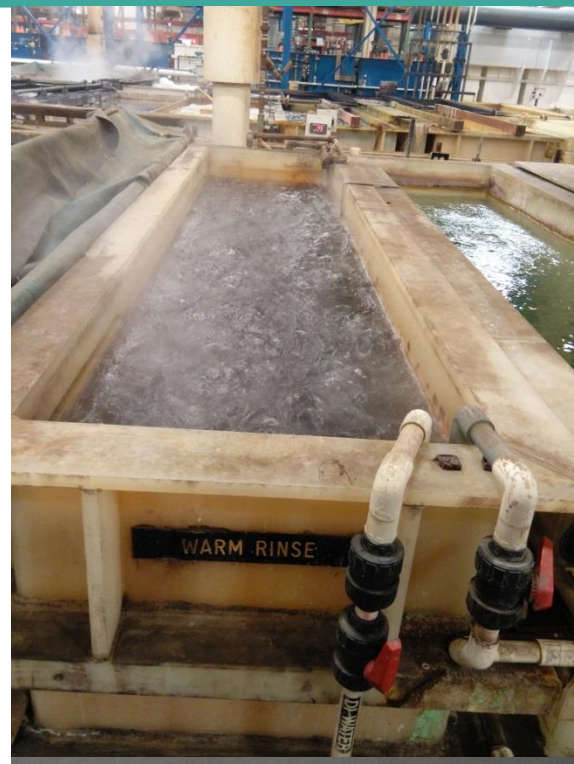


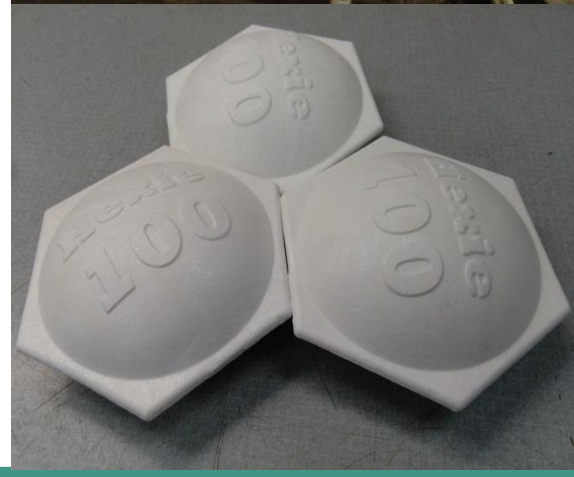

- **Cost Analysis**
  - Requires additional piping, no operating costs

| Water Savings (gal/year) | Water Savings ($/year) | Capital Cost | Payback Period (months) |
|---|---|---|---|
| 2,000,000 | $14,500 | $2,400 | 2 |

# Floating Insulation for Open Tanks

- **Evaporation**
  - 1,500,000 gallons evaporated from heated open tanks
  - Evaporated water costs $7,700 yearly
- **Heat Loss**
  - Nearly 100,000 therms per year lost to environment
  - Hard to control temperature for agitated tanks
- **Solution**
  - Covering tanks reduces heat loss by 80% and evaporation by 70%
  - Floating tank insulation (Hexies) still allows parts access to tanks



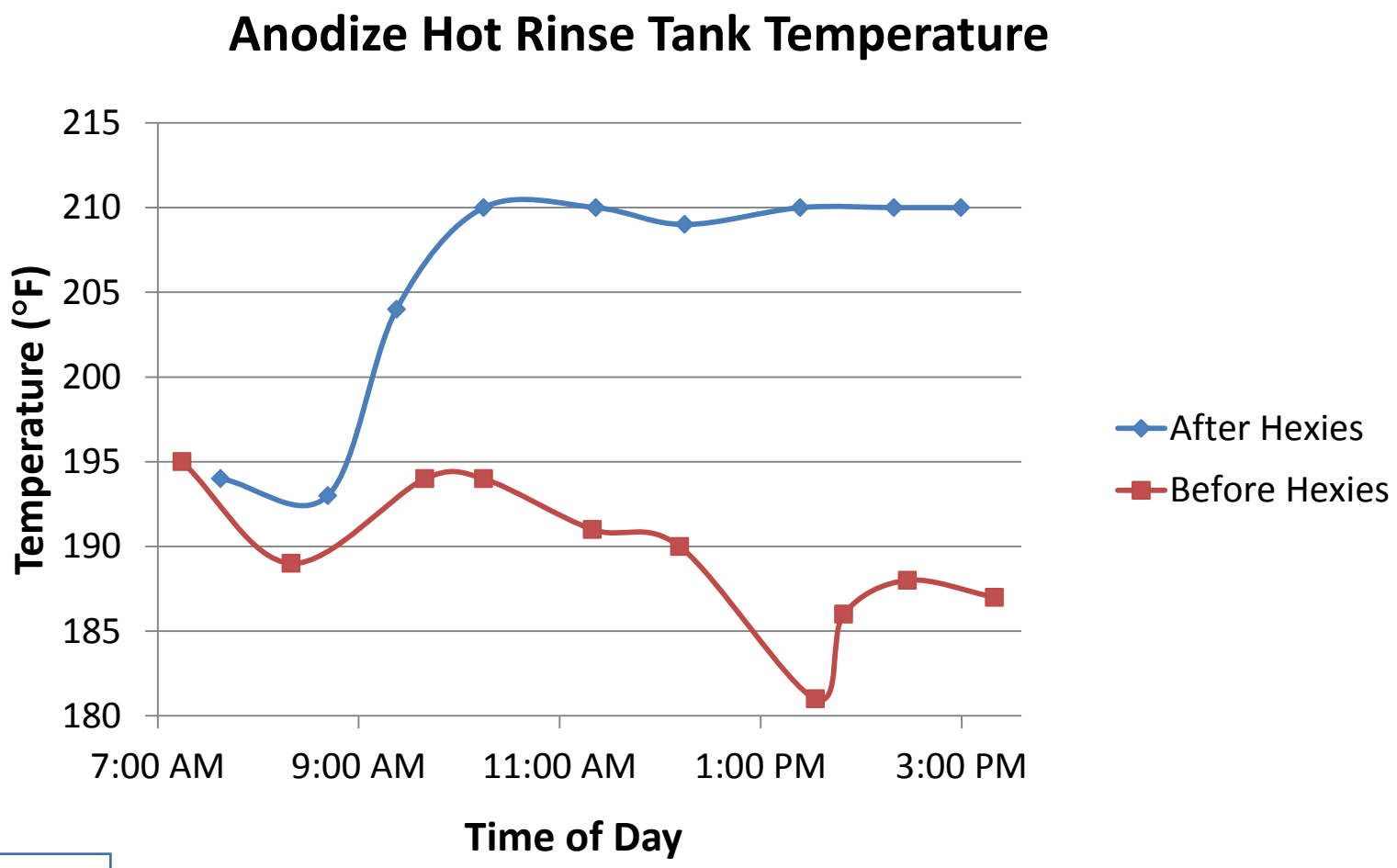



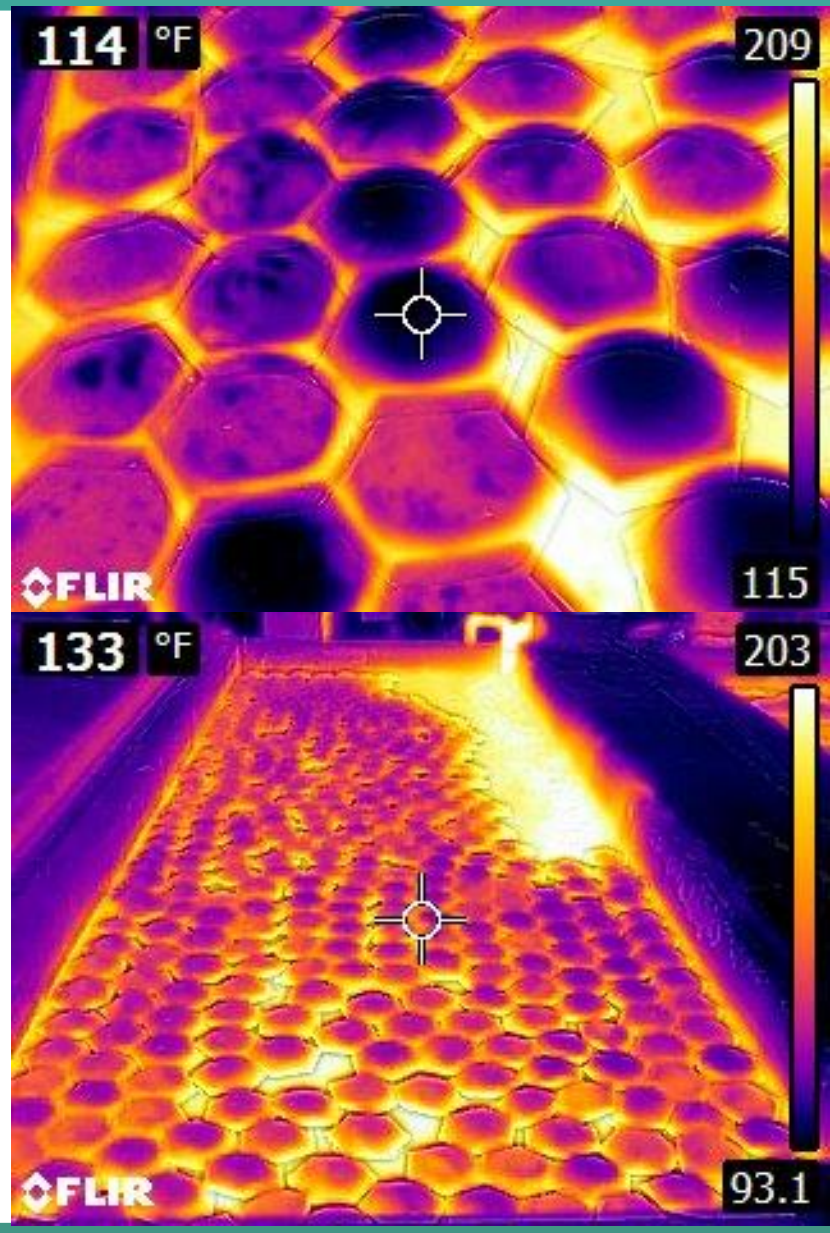
# Test on Anodize Hot Water Seal

- **Implementation**
  - Difficulty keeping temperature high enough
  - Estimated heat loss of 7,700 therms
  - 64,000 gallons of water evaporated yearly
  - Costs $600 to cover 38.5 $ft^2$ tank
  - Can't use for thin and small parts


| Water Savings (gal/year) | Water Savings ($/year) | Heat Savings (therms/year) | Heat Savings ($/year) | Capital Cost | Net Savings ($/year) | Payback Period (months) |
|---|---|---|---|---|---|---|
| 1,065,000 | $7,700 | 81,000 | $59,000 | $11,300 | $55,300 | 3 |

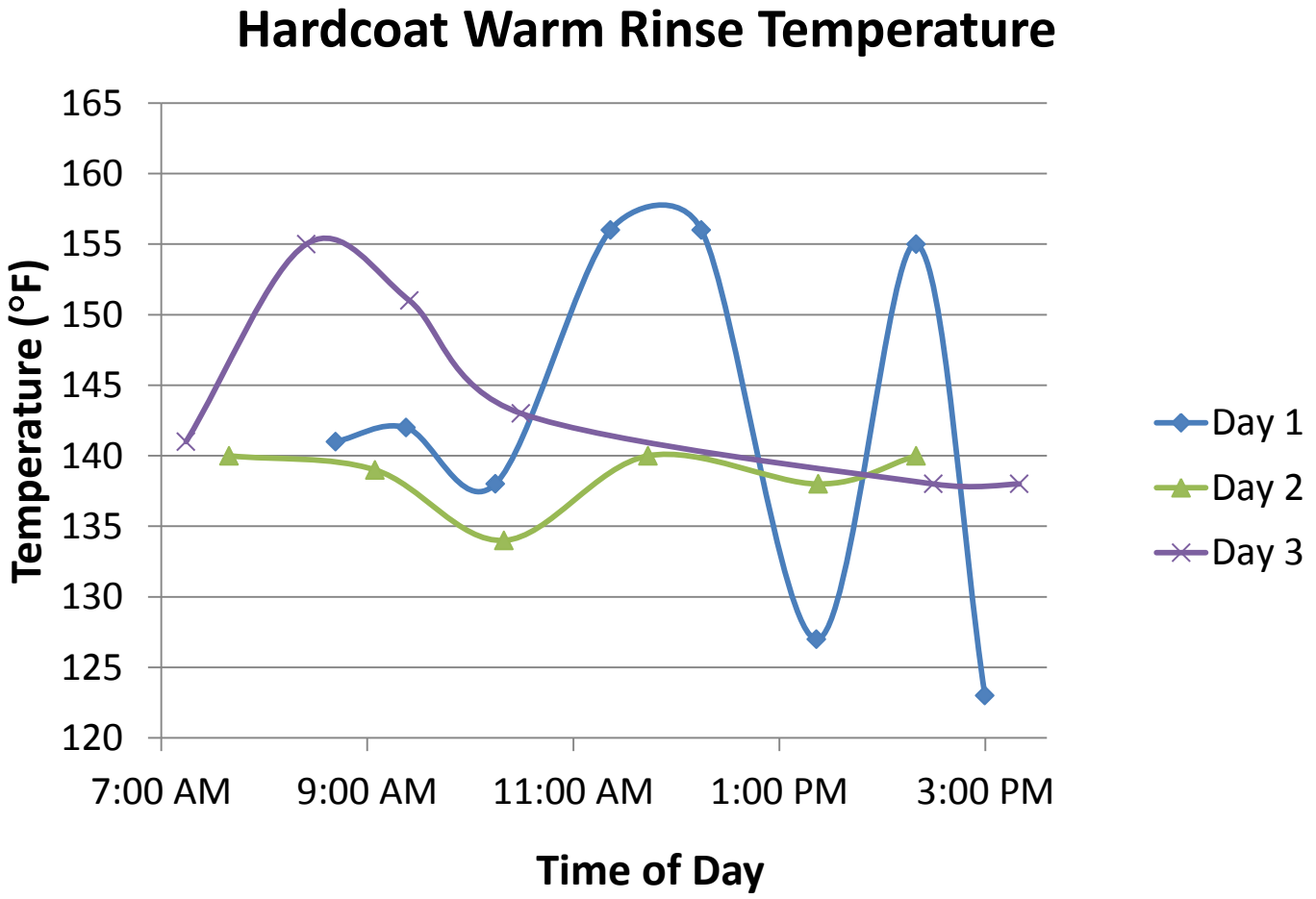
# Test Results



# Further Implementation

- **Hardcoat Warm Rinse**
  - Costs $400 to cover 18 $ft^2$ tank
  - Heat loss of 1,000 therms
  - 14,000 gallons evaporated
  - Payback period: 6 months
- **Other Heated Tanks**
  - Tanks with problems getting to high enough temperatures
  - Hot rinses have easiest implementation



# Waste Treatment Optimization

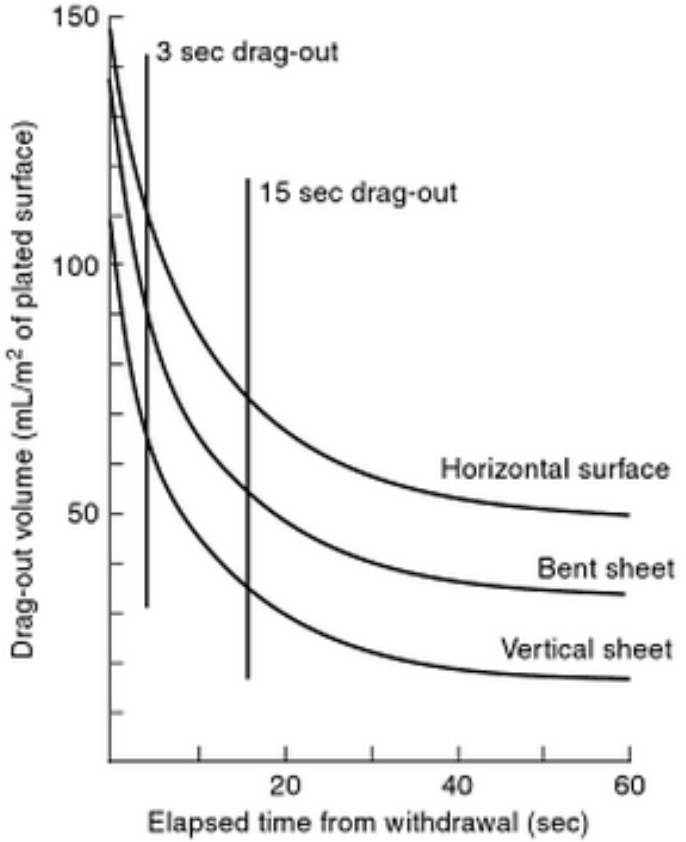
- **Ferrous sulfate for chrome reduction**
  - To reduce hexavalent chrome reaction occurs at pH 2-3, but to precipitate chrome need pH 7-9
  - Determined if change in pH and reduced chemical additions could favor replacing sodium metabisulfite
  - Less chemicals used to adjust pH, less sludge
  - Lab scale test: used 3 times stoichiometric amount, reduced chrome from 240 ppm to 8.6 ppm at a pH of 5
  - Would still need to lower pH to be effective

# Waste Treatment Optimization (continued)

- **Ozone for cyanide destruction**
  - No chemicals need to be stored, only operating cost is electricity
  - Pure oxygen and ozone produced and destroyed on site
  - Less labor dedicated to handling chemicals
  - Remote operation and control
- **Cost Analysis**
  - $90/day electricity cost vs. $135/day chemical costs
  - Reduced sludge by 5,000 lbs. and better control
  - $250,000 capital cost, but net savings only $16,000 per year from reduced sludge, maintenance, and chemical use

# Waste Treatment Optimization (continued)

- **Electroplating Waste Reduction**
  - Changing chemistries/treatment methods expensive or ineffective
  - Most cost efficient method still reducing dragout to rinses
  - Dragout reduction by reducing part drip time still recommended




EPA: Meeting Hazardous Waste Requirements for Metal Finishers

# Project Summary

| Recommendation | Reduction (per year) | Implementation Cost | Net Savings ($/year) | Payback Period | Status |
|---|---|---|---|---|---|
| Closed Loop Water System | 15,000,000 gallons water | $130,000 | $63,000 | 25 months | Recommended |
| Reuse RO Rinse Water | 2,000,000 gallons water | $2,400 | $14,000 | 2 months | Recommended |
| Floating Insulation for Open Tanks | 1,000,000 gallons water<br>80,000 therms | $12,000 | $55,300 | 3 months | Implementing |
| Drum Evaporator | 19,000 lbs. hazardous waste | $9,600 | $8,100 | 14 months | Recommended |

# MnTAP Internship Benefits

- Industry experience
- Apply classroom knowledge to real-world problems
- Learn about new processes
- In charge of own project
- Propose, implement, and test real solutions

# Thank You!

# Questions?