Waste Process Optimization
ECO Finishing
Jerico Sanchez Hulstrand
MnTAP Advisor: Michelle Gage
Company Supervisor: Paul Madden
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)

<table>
<thead>
<tr>
<th>Water Savings (gal/year)</th>
<th>Water Savings ($/year)</th>
<th>Capital Cost ($/year)</th>
<th>Operating and Maintenance ($/year)</th>
<th>Net Savings ($/year)</th>
<th>Payback Period (months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15,000,000</td>
<td>$110,000</td>
<td>$130,000</td>
<td>$47,000</td>
<td>$63,000</td>
<td>25</td>
</tr>
</tbody>
</table>
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

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<tbody>
<tr>
<td>19,000</td>
<td>$10,800</td>
<td>$9,600</td>
<td>$2,700</td>
<td>$8,100</td>
<td>14</td>
</tr>
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</table>
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

<table>
<thead>
<tr>
<th>Water Savings (gal/year)</th>
<th>Water Savings ($/year)</th>
<th>Capital Cost</th>
<th>Payback Period (months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,000,000</td>
<td>$14,500</td>
<td>$2,400</td>
<td>2</td>
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</table>
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

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<tbody>
<tr>
<td>1,065,000</td>
<td>$7,700</td>
<td>81,000</td>
<td>$59,000</td>
<td>$11,300</td>
<td>$55,300</td>
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Test Results

Anodize Hot Rinse Tank Temperature

<table>
<thead>
<tr>
<th>Time of Day</th>
<th>Temperature (°F)</th>
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<tbody>
<tr>
<td>7:00 AM</td>
<td>180</td>
</tr>
<tr>
<td>9:00 AM</td>
<td>185</td>
</tr>
<tr>
<td>11:00 AM</td>
<td>190</td>
</tr>
<tr>
<td>1:00 PM</td>
<td>195</td>
</tr>
<tr>
<td>3:00 PM</td>
<td>200</td>
</tr>
</tbody>
</table>

- **After Hexies**
- **Before Hexies**
Further Implementation

- **Hardcoat Warm Rinse**
  - Costs $400 to cover 18 ft² 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

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![Graph of Hardcoat Warm Rinse Temperature over three days. The graph shows the temperature in °F at different times of the day, with the highest temperatures occurring around 1:00 PM and the lowest around 7:00 AM on all three days. The graph is labeled with different colored lines for each day (Day 1, Day 2, and Day 3).]
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

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