Reduced Air Emissions for Hard Chrome Plating at the NADEP NAS North Island, San Diego

Using an Alternative Emission Control Technology

Presented by: Terry Hutchins
Sales & Marketing Manager
Equipment Division
Palm International, Incorporated
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The NADEP’s Hard Chrome Plating Facility

The NADEP facility located on the NAS North Island, San Diego, CA currently has five (5) hard chrome plating tanks in operation. The facility typically plates 3-5 million amp-hours per year and is identified as a Small Hard Chromium Electroplating Facility by the San Diego Air Pollution Control District.
The NADEP’s Cr$^{+6}$ Permit Conditions

“THE HEXAVALENT CHROMIUM EMISSIONS SHALL NOT EXCEED 0.233 POUNDS IN EVERY CONSECUTIVE 12-MONTH PERIOD. THE HEXAVALENT CHROMIUM SHALL BE DETERMINED USING THE THREE MOST RECENT APPLICABLE SOURCE TESTS APPROVED BY THE DISTRICT* FOR THE ABOVE EQUIPMENT.”

* San Diego Air Pollution Control District
The NADEP’s Current Air Pollution Control Device

The NADEP currently incorporates a 40,000 CFM Mesh Pad Mist Eliminator Exhaust System driven by a 100 HP motor as its add-on control device. The measured Cr$^{+6}$ emissions at the stack is 0.0015 mg/amp hour. At this emission level, the NADEP could plate approximately 70 million amp hours annually and remain in compliance with their permit. The exhaust fan motor is operated 24 hours per day 7 days per week at an average cost of 10.7 cents per kilowatt hour.
ENCAPSULATING TANK COVERS

This presentation addresses the implementation of encapsulating tank covers, hereafter referred to as the Chrome Plating Emission Elimination Device (EED), on the NADEP’s hard chrome plating process tanks, as an alternate control devise used to eliminate Cr⁶⁺ emissions to the outside environment, reduce operating costs, and provide enhanced operator safety and exposure in the chrome plating facility.
EED DEFINITION

As a stand-alone, self-contained system requiring no exhaust fans, scrubbers or mesh pad mist eliminators, fume suppressants, or exhaust ducts and vents to the outside environment, the EED System has by definition, zero emissions to the outside environment.
CONVENTIONAL EXHAUST SYSTEM

Mesh Pad Mist Eliminator

HEPA-Filters

Exhaust Fan

In-Line Mesh Pad Mist Eliminator

Conventional Exhaust System

Chrome 1
Chrome 2
Chrome 3
SAME TANKS WITH EED SYSTEM

EED Systems

Chrome 1

Chrome 2

Chrome 3

EED Cover

Water Seal

EED Adapter Plate
BUILDING AN EED SYSTEM

The EED system is comprised of the following components:

• Chrome Plating Tank
• Adapter Plate-Tank Lip Seal
• EED Adapter Plate w/Water Seal
• EED Membrane & Frame
• EED Membrane Cover
• EED Evacuation System
BUILDING AN EED SYSTEM

Chromic Acid Plating Solution

Operating Temperature: 135-140°F

Two-Piece Membrane Frame:
1/2" PVC Material

Copper Anode Rods

Miscellaneous Penetrations:
Heating, Cooling, Solution Recirculation, etc.

EED Membrane Cover - 16-Gauge T-304SS

EED Membrane Media
Pore Size: 0.1 micron
Sized at 2 Square Foot/1000 Amps DC Current

EED Cover - 10 to 12 Gauge T-316SS

Water Seal Trough Integral to Adapter Plate

EED Adapter Plate - FRP CoRezyn 8441
Fire Retardant Vinyl ester
3/8" Thick, Nominal

EED Adapter Plate Seal
3/16" Thick Neoprene Rubber

Chrome Plating Tank
BUILDING AN EED SYSTEM
THEORY OF OPERATION

Chromic Acid Plating Solution

Operating Temperature: 135-140°F

Condensation Zone

Water Vapor Zone

Hydrogen & Oxygen Gases

EED Membrane Cover - T-304SS
EED Membrane
EED Cover - T-316 SS

Water Seal Trough

EED Adapter Plate - FRP
EED Adapter Plate Seal

Chrome Plating Tank

Particle Size 6-7
THEORY OF OPERATION

EED Operation:

As chrome plating takes place, several things occur simultaneously beneath the EED cover. Water vapor is created due to the 135°F operating temperature of the hard chrome bath. Chrome mist is generated due to electrolysis. Additionally, hydrogen and oxygen gasses are created at the cathode and anode due to the inefficiency of the hard chrome plating bath. As the water vapor rises beneath the cover, a cloud forms blanketing the plating solution. Chrome mist that comes in contact with the cloud is “washed” by the water vapor, creating heavy chrome droplets that fall, by gravity, back into the plating tank. As the water vapor continues to rise, it comes in contact with the cover, condenses, forms water droplets, which in turn fall back into the water seal trough and plating tank. The hydrogen and oxygen gasses rise to the highest point beneath the cover where the patented membrane allows free passage of these gases into the atmosphere.
THE EVACUATION SYSTEM

- Evacuation Pipe
- EED Moisture Separator
- EED Inline Filter
- EED Final HEPA Filter
- EED Regenerative Blower
- Air Flow From Chrome Plate Tank
Evacuation System Operation:

On completion of the plating cycle, residual hydrogen and oxygen gasses and water vapor must be evacuated from the unit prior to opening the cover. Once the rectifier has been turned off, it takes approximately 3-5 minutes to complete this effort. The evacuation system consists of a regenerative blower, moisture separator, pre-filter and final HEPA filter. The operation is as follows: The blower is activated, the air flow passes through the moisture separator where residual moisture is collected, through the pre-filter, into the blower, and finally into the room atmosphere through a 0.3 micron HEPA filter.
Indoor Air Quality - Monitoring Chromium\textsuperscript{+6} Emissions at Evacuation Filter

- Measured Results: 0.003
- OSHA Limit: 0.10
- Cal/OSHA Limit: 0.05
- NIOSH Limit: 0.025
- ACGIH Limit: 0.05
PROPOSED NADEP EED SYSTEM, TANK NO. 1

NADEP Building 472
Chrome Plating Area
EED System 1005
PROPOSED NADEP EED SYSTEM, TANK NO. 1

Solution Flow

Air Flow

EED MCC
PROPOSED NADEP EED SYSTEMS
ADVANTAGES OF THE EED

- Associated scrubber costs are eliminated.
- Potentially leaking ductwork eliminated.
- Heated make-up air requirements are eliminated.
- Fume suppressants are no longer needed.
- Energy requirements are reduced by 60-70%.
- Floor space requirements could be reduced.
- Long life estimated to be 15 years or longer.
### ESTIMATED EED COST & PAYBACK ANALYSIS

**FIVE-TANK SYSTEM**  
NADEP - SAN DIEGO, CA  
Tank Size - Length: 101" x Width: 34"

<table>
<thead>
<tr>
<th></th>
<th>Conventional Chrome Plating Tank</th>
<th>Chrome Plating Tank w/EED System</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>EED Equipment Cost (including installation)</strong></td>
<td>$ -</td>
<td>$ 293,715</td>
</tr>
<tr>
<td><strong>Total System Cost</strong></td>
<td>$ -</td>
<td>$ 293,715</td>
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#### **ANNUAL ESTIMATED OPERATING COST**

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
<th>Cost/kWHR</th>
<th>Fan Motor HP</th>
<th>Amperes</th>
<th>kW</th>
<th>kWHours</th>
<th>Cost/kWHR</th>
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<tr>
<td><strong>Electrical Cost</strong></td>
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<td>$ 0.107</td>
<td>100</td>
<td>127.37</td>
<td>81.09</td>
<td>710,322</td>
<td>0.107</td>
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<tr>
<td><strong>Make-up Air Cost (no heat)</strong></td>
<td></td>
<td>$ 0.107</td>
<td>30</td>
<td>38.21</td>
<td>24.33</td>
<td>213,097</td>
<td>0.107</td>
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<tr>
<td><strong>Push Air Blower</strong></td>
<td></td>
<td>$ 0.107</td>
<td>50</td>
<td>63.68</td>
<td>40.54</td>
<td>355,161</td>
<td>0.107</td>
</tr>
<tr>
<td><strong>Annual Source Test</strong></td>
<td></td>
<td>$ 0.107</td>
<td>50</td>
<td>63.68</td>
<td>40.54</td>
<td>355,161</td>
<td>0.107</td>
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<tr>
<td><strong>Annual Maintenance Cost</strong></td>
<td></td>
<td>$ 0.107</td>
<td>50</td>
<td>63.68</td>
<td>40.54</td>
<td>355,161</td>
<td>0.107</td>
</tr>
<tr>
<td><strong>Annual Operating Cost</strong></td>
<td></td>
<td>$ 10,000.00</td>
<td>50</td>
<td>63.68</td>
<td>40.54</td>
<td>355,161</td>
<td>0.107</td>
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<tr>
<td><strong>Annual Operating Cost</strong></td>
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<td>$ 3,590.00</td>
<td>50</td>
<td>63.68</td>
<td>40.54</td>
<td>355,161</td>
<td>0.107</td>
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</table>

**Water Treatment Costs** $2,500.00  
**Annual Maintenance Cost** $1,500.00  
**Total First Year Cost** $294,715
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<tr>
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<th>First Year Equipment Cost</th>
<th>First Year Operating Cost</th>
<th>Exhaust System Investment</th>
<th>EED System Investment</th>
<th>Equipment Savings</th>
<th>One-Year Operating Cost Savings</th>
<th>Total Savings One Year</th>
<th>First Year Savings</th>
<th>Second Year Savings</th>
<th>Pay Back - Months</th>
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<tr>
<td><strong>Total First Year Cost</strong></td>
<td>$ -</td>
<td>$ 150,808</td>
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<td><strong>10 Year Estimated Cost</strong></td>
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<tr>
<td>Total Installation Cost</td>
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<tr>
<td>10-Year Operating Cost (per above)</td>
<td>$ 1,508,080</td>
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<tr>
<td><strong>Total Ten Year Cost</strong></td>
<td>$ 1,508,080</td>
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<tr>
<td><strong>Projected Ten Year Savings</strong></td>
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<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
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<td>$ 1,181,055</td>
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**EED Payback Analysis**

- Total 1st Year Cost: $294,715
- 10-Year Operating Cost (per above): $32,310
- Total Ten Year Cost: $327,025
ADVANTAGES OF THE EED

- Reduced danger of hydrogen explosion; rectifiers are off during start-up – preventing arcing.
- The patented design allows hydrogen to freely leave the EED. In the unlikely event of an explosion, the EED shields the operator from any splashing solution.
- Potential hood or duct fires eliminated.
- Noise from fan and pump motors is eliminated.
- The potential for worker exposure is minimized when the EED is installed because no Cr\textsuperscript{+6} molecules are emitted to the atmosphere while plating is taking place.
Indoor Air Quality - Monitoring Chromium\textsuperscript{+6} Emissions

Sample ID (Sample Time: Approximately 300 Minutes)

<table>
<thead>
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<th>Sample ID</th>
<th>Actual Results</th>
<th>OSHA Limit</th>
<th>ACGIH Limit</th>
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<tr>
<td>1</td>
<td>0.02</td>
<td>0.1</td>
<td>0.06</td>
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<td>2</td>
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<tr>
<td>4</td>
<td>0.08</td>
<td>0.1</td>
<td>0.06</td>
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</table>
ADVANTAGES OF THE EED

• **Air:** The need for exhaust hoods, ductwork and fume scrubbers/fans is eliminated.

  *Air:* With a properly installed and operated EED system, emissions are eliminated.

• **Air:** Because no exhaust stacks are required, chrome fumes cannot escape into the atmosphere as they could if the scrubber system fails. The EED is environmentally friendly.

• **Water:** Effluent control for treating scrubber solutions is no longer required.
ADVANTAGES OF THE EED

• Since there are no exhaust stacks with the EED, no exhaust operational reports are required. Stack source testing is eliminated resulting in savings of $10,000 annually, as required by local regulatory authorities.
ADVANTAGES OF THE EED

• Because the EED includes a cover that must be opened, operators become more aware of their work habits. Production throughput will actually improve due this renewed attention to procedures.
CONCLUSIONS

The EED System, when operated properly, is a proven alternative control device that will meet or exceed all requirements of the Chrome Plating NESHAP while eliminating the need for conventional ventilation systems and fume suppressants. Due to the simple design and operation of the EED, significant savings are achievable using this technology when compared to conventional exhaust systems. In the particular case of the NADEP, as shown above, ten-year savings are estimated to be greater than $1.18 Million with an investment payback of approximately 24 months.