Breakout Session 1

"Hydraulic and Pneumatic Actuator Breakout Session."

Chromium plating

Chromium plating is used on pistons and cylinder housings and is often used for rebuilding. Current options for alternatives are HVOF and plasma spray coating. Small actuators could be a future issue. It can be expensive to change coatings.

Aluminum housing is common in the aerospace industry due to weight considerations; however, there may be chemical issues for using a weight alternate for chromium on aluminum. The group discussed additional concerns with re-sleeving.

Drivers behind chromium replacement include performance enhancement and a movement toward "green" coatings. One technological pull for replacement would be determining a set amount of time an actuator is needed to last.

A specialized plasma spray gun would be needed to coat small IDs (e.g., 3 inches).

Engineers are very familiar with chromium and are often reluctant to change.

Chromium Plating Priorities:

1. Applications: Piston (OD), Cylinder (ID), linkage pins

2. Performed in-house (re-work) or by vendor (replacement)

3. Regulatory compliance issues: There are no issues for plating at Navy Depots (no added category to comply with new OSHA regulations)

4. Performance "Requirements:" wear resistance (surface, finish, hardness, etc.), corrosion resistance

5. Alternatives: HVOF, WC-Co, WC-Co-Cr on OD, plasma spray

6. Implementation Barriers: No ban on chromium plating yet, not always a performance or life benefit, alternatives more expensive, difficulty getting stakeholders interested (no centralized engineering authority). Changing a coating could have an impact on existing pretreatments and post-treatments - a systems approach is needed. Changing a coating could result in changing a part number, which leads to configuration control issues. Existing planned maintenance cycles will be shorter than the cycles appropriate for better performing alternatives leading to logistics issues and possibly unnecessary depot operations.

7. Remaining Needs: Small ID coating

Additional items added from workshop discussion:

- Also need a replacement for thin dense (nodular) chromium coatings
- Reliable and useful cost data are difficult to obtain
- DoD may learn from why industry uses alternatives (i.e., their business case)
- RDT&E is good but need to follow up with implementation and technical support
- The HCAT has done a good job in getting the right people together and focusing on alternatives for specific applications (e.g., landing gear, gas turbine engines).

Cadmium

Cadmium-plated parts on pneumatic components include steel housing and fasteners. The biggest push to eliminate cadmium comes from an Executive Order. However, because the Executive Order does not include funding, there is an issue of compliance. The cost of the paperwork to make changes (i.e., updating manuals) can be costly. There is no driver to eliminate cadmium from Legacy systems.

Alternatives to cadmium include Alumiplate and zinc-nickel (alkaline). It is unlikely that depots will ever carry Alumiplate due to the amount of toluene involved. If Alumiplate becomes the coating of choice, depots would need to rely on nearby facilities for repairs. IVD aluminum is another high cost alternative to cadmium.

Remaining Needs (Cadmium)

1. Current and Long Term Needs
   HVOF is good for ODs, but still need solutions for IDs/NLIS, where plasma isn't suitable (for dimensional restoration/wear restoration)

2. Low Hanging Fruit
   Actuator community will follow others in replacements
   HVOF on piston ODs (OEMs already beginning to implement)

3. Data, Validation, Testing, Apparent Needs
   Data for HVOF on ODs is probably sufficient, but will likely require some focused testing for specific actuators before approval will be granted.

4. What's Not Happening and Why?
   There is no clear impetus for change based on a cost-benefit analysis.
   Cost of complying with regulations is acceptable
   Performance improvement is not big enough
   Legacy aircraft reaching retirement before payoff is obtained

5. RDT&E Needs? Which Organizations Need What?
   Development or maturation of ID processes
   Lower cost solutions

6. Broad Barriers/Missing Knowledge

Specifications and standards
Funding
Knowledge of options by engineers and managers
Need stronger drivers for change
Need to educate all levels of management about policy and associated organizational direction
Need funding and directives to project manager level

Nickel and chromates (notes added from participants)

1. Electroless nickel (Ni-P) is only used on a few small parts and pneumatic components
2. Nickel is not as regulated so not a current issue ("not on the radar screen yet")
3. Some R&D cobalt based coatings have promise, but little incentive to develop further
4. Trivalent chromium based pretreatments are now available commercially to replace chromated conversion coatings, rinses, etc. - Cr(III) considered by some to not be regulated like Cr(VI)
5. Chromium-free pretreatments usually used with chromated primers for best performance in service - recent trend is to develop a totally chromium-free paint system.

Impact of New and Imminent OSHA/EPA/EU Regulations

6. Lack full understanding of regulatory requirements and true cost of compliance (e.g., PPE costs for entire facilities)

7. Understanding and cost differs from location to location

8. Elimination of cadmium, nickel, and chromium are low priorities for the actuator community, but they will follow as other communities implement changes

Discussion Topics from May 23, 2006

- Chrome on smaller engine actuators can be problematic.

- For surface finishing, do newer materials not work as well? Even if they are effective, they still add cost.

- RDT&E priority: research and development for Non Line-of-Sight. Chromium in bath is the highest priority for actuators.

- What is the cost comparison between HVOF and chromium? HVOF is a more expensive process, but the life cycle is longer. Vendors charge more for HVOF because the services are specialized or because they receive less business as a

whole. There is an order of magnitude difference in price for small actuators. Cost savings led the Air Force to change out to HVOF on actuators and landing gear.

- Drivers to change chrome coatings include the push to eliminate chromium in European markets and increased performance. However, the customer may not recognize the benefits for the higher costs.