

Weight Loss Immersion Test of Thermal Spray-coated Disk Specimens

INTRODUCTION

- Various thermal spray coatings applied by the high velocity oxygen-fuel (HVOF) technique are candidates for replacing hard-chromium plating on certain aircraft components. These components are likely to contact a variety of fluids that might affect the HVOF coating. ARINC conducted immersion tests of HVOF-coated disk specimens to evaluate resistance to fluids that might be present during aircraft operation and maintenance.

Test Specimens

- 1-inch diameter disk specimens of 4340 steel, 0.05 inch thick. Each coating was nominally 0.0055 inch thick and there were 25 disk specimens for each coating. These test specimens were coated on both faces with one of the following HVOF coatings:
 - Co-28Mo-8Cr-2Si designated Tribaloy-400
 - WC/10Co4Cr HVOF designated WC/CoCr
 - Cr₃C₂/20NiCr HVOF designated CrC/NiCr

List of Fluids

- MIL-PRF-83282 hydraulic fluid
- Skydrol AS1241 Type 4 hydraulic fluid
- Non-destructive inspection (NDI) fluorescent penetrant dye, ARDROX 985-P14
- Propylene glycol, commonly used for de-icing procedures
- Nital etchant, a 4% by volume mixture of nitric acid in alcohol
- Ammonium persulfate etchant, 10% by weight mixture with water
- MIL-C-87937 cleaner, d-limonene based, mixed one part cleaner to two parts water
- Oakite 90 cleaner, mixed 8.5 ounces per gallon of water
- Chlorine bleach, sodium hypochlorite, common household bleach mixed 60% with water to yield a solution of approximately 3% by volume NaOCl
- Cee-Bee J-84A, a high pH, heavy duty degreaser, mixed 8.5 ounces per gallon of water
- Turco Vitro-Klene heavy duty soak cleaner, mixed 8.5 ounces per gallon of water
- JP-5 jet fuel

Discussion of Results For Each Fluid

MIL-PRF-83282 Hydraulic Fluid

- Mass change after immersion: Increase, due to fluid retention.
- Mass change after extended air-dry: Further increase, apparent moisture absorption.
- Visual examination comparison before and after immersion: No change.
- Surface roughness measurement: No change.

Skydrol AS1241 Type 4 Hydraulic Fluid

- Mass change after immersion: Invalid results.
- Mass change after extended air-dry: Invalid results.
- Visual examination comparison before and after immersion: No change.
- Surface roughness measurement: No change.

Non-destructive Inspection (NDI) Fluorescent Penetrant Dye, ARDROX 985 P14

- Mass change after immersion: Increase, due to fluid retention.
- Mass change after extended air-dry: Decreased approaching zero net change.
- Visual examination comparison before and after immersion: No change.
- Surface roughness measurement: No change.

Propylene Glycol

- Mass change after immersion: Negligible change.
- Mass change after extended air-dry: Slight decrease.
- Visual examination comparison before and after immersion: No change.
- Surface roughness measurement: No change.

Nital Etchant

- Mass change after immersion: Slight increase.
- Mass change after extended air-dry: Decreased to essentially no mass change.
- Visual examination comparison before and after immersion: No change.
- Surface roughness measurement: No change.

Ammonium Persulfate Etchant

- Mass change after immersion: Negligible change.
- Mass change after extended air-dry: Slight decrease.
- Visual examination comparison before and after immersion: No change.
- Surface roughness measurement: No change.

MIL-C-87937 Cleaner, d-Limonene Based

- Mass change after immersion: Increase, due to fluid retention.
- Mass change after extended air-dry: Substantial decrease.
- Visual examination comparison before and after immersion: No change.
- Surface roughness measurement: No change.

Oakite 90

- Mass change after immersion: Slight increase.
- Mass change after extended air-dry: Decreased to approximately no-change.
- Visual examination comparison before and after immersion: No change.
- Surface roughness measurement: No change.

Chlorine Bleach, Sodium Hypochlorite

- Mass change after immersion: Decreased significantly.
- Mass change after extended air-dry: Further decrease, perhaps loose particles lost.
- Visual examination comparison before and after immersion: Obvious degradation.
- Surface roughness measurement: Obvious surface effect and roughening of the Tribaloy-400.

Chlorine Bleach, Sodium Hypochlorite (cont)

- The bleach solution aggressively attacked WC/CoCr, and the effect was visually obvious, both during the immersion and after cleaning. The bleach solution attacked the cobalt-containing Tribaloy-400 even more aggressively than the WC/CoCr.
- The bleach had little effect on CrC/NiCr, which contained no cobalt.

Specimen Immersed in Chlorine Bleach, Sodium Hypochlorite



Cee-Bee J-84A

- Mass change after immersion: Slight increase.
- Mass change after extended air-dry: Decreased to approximately no-change.
- Visual examination comparison before and after immersion: No change.
- Surface roughness measurement: No change.

Turco Vitro-Klene

- Mass change after immersion: Slight increase.
- Mass change after extended air-dry: Decreased to approximately no-change.
- Visual examination comparison before and after immersion: No change.
- Surface roughness measurement: No change.

JP-5 Jet Fuel

- Mass change after immersion: Increased.
- Mass change after extended air-dry:
Decreased to approximately no-change.
- Visual examination comparison before and after immersion: No change.
- Surface roughness measurement: No change.

Conclusion

- The Tribaloy-400 HVOF coating might be ill-suited to applications where it might be exposed to strong cleaning agents or other reactive chemicals.
- CrC/NiCr HVOF coating and WC/CoCr HVOF coating can both be expected to resist common liquids during service and maintenance, but procedures should emphasize the danger of exposing WC/CoCr sodium hypochlorite bleach, and measures should be implemented to guard against its use.