Center Electrode Life Test of an Iridium Alloy

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Introduction:

This summer I worked at Woodward in Greenville, SC. Woodward integrates leading-edge technologies into fuel, combustion, fluid, actuation, and electronic control systems for the aerospace and energy markets. A few of the products manufactured at the Greenville location are: injectors, nozzles, swirlers, and igniters.

Background:

- Conditions inside an Industrial Gas Turbine (IGT) engine vary depending on a variety of factors: fuel, emissions, materials, etc.
- Sometimes igniters spark when wet (water or fuel)
- Wet igniters erode at a higher rate than dry igniters

Purpose of test:

- The purpose of this project was to perform a dry and a fully submerged (wet) spark test on a production igniter with a center electrode made of an Ir alloy. A comparison was then made between the resultant center and a production part.

Figure 1. Igniter

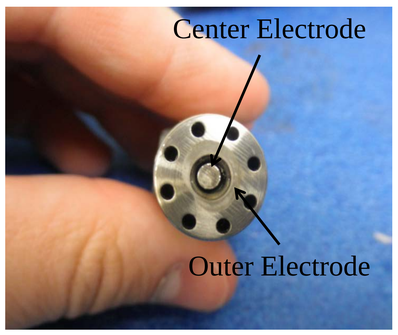


Figure 2. Igniter Tip

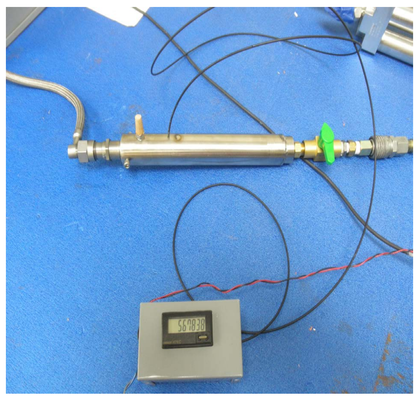


Figure 3. Dry Spark Test - Apparatus

Dry Spark Test:

- Sparks controlled using exciter
- Igniter encased in tube
- Cooled by air
- Sparks counted using fiber optics
- Test terminated after 567,838 sparks

Figure 4. Wet Spark Test – Apparatus, Inside View

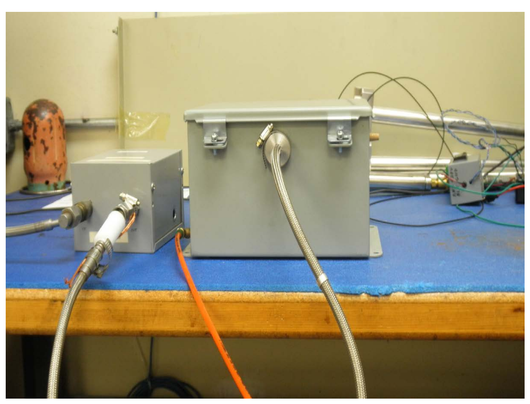


Figure 5. Wet Spark Test – Apparatus, Outside View

Wet Spark Test:

- Sparks controlled using exciter
- Sparks counted using an oscilloscope – displayed a voltage output from a10:1 current transformer, Pearson Model 110 Current Monitor
- Igniter fully submerged in JP4 fuel
- Expandable bellows used to hold fuel/igniter as well as contain the sparks
- Test apparatus contained in an explosion rated steel enclosure, shielded with argon gas
- Test terminated after 126,028 sparks

Results:

- **Dry Spark Test**
  - Majority of material lost came from outer electrode
  - Ir alloy outperformed previous baseline life test
- **Wet Spark Test – Baseline**
  - Baseline has a faster volumetric wear rate than new alloy, approx 2x faster
  - Larger diameter: 0.123” vs. 0.100”
  - Center electrode eroded to inside insulator
- **Wet Spark Test - Alloy**
  - Faster wear rate than dry spark, approximately 18 times faster
  - More wear on center electrode versus dry

Figure 6. Dry Spark Tip – End of Test

Figure 7. Alloy Wet Spark Test – End of Test

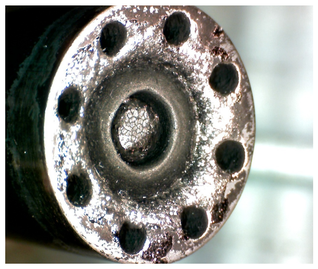
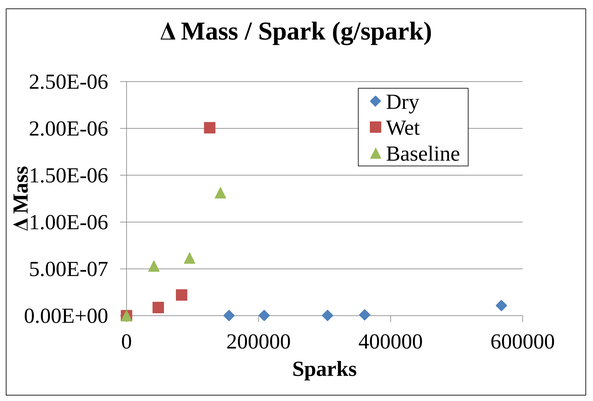
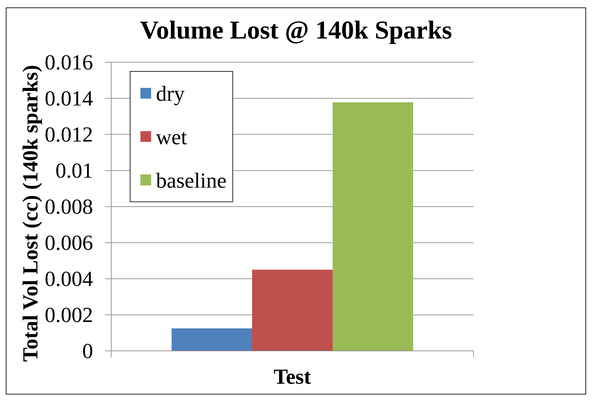


Figure 8. Baseline Wet Spark Test – End of Test





- **Appears that wear rate is a function of both material composition and geometry, not just linear function**