Seat Cushion Test Method Update

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Introduction

• Continue working to setup and calibrate sonic burner for use with seat cushion test method for the purpose of replacing Park Burner

• Calibration and testing has been ongoing in an attempt to setup the sonic burner such that it will reproduce Park burner test results

• The advantage of the sonic burner is that it is capable of producing more consistent results than the Park burner
Summary of Last Meeting

- **Flow tested new nozzles**
  - Checked for consistency in flow rates

- **Testing nozzles in sonic burner**
  - Nozzle clocking to check for uniform flame temperature distribution using thermocouple rake

- **Seat cushion tests using sonic burner**
  - Data collected using old Park burner and Monarch nozzles will be compared to data taken using new nozzles and sonic burner

- **Thermocouple Temperature Drift**
  - Thermocouple temperature measurements drop off after repeated heat cycling
Fuel Nozzle Flow Rate

- **Delevan Nozzle Flow Check**
  - The Delevan nozzles were checked on a bench top flow testing rig. The results show, that compared to the typical Monarch nozzles, the Delevan nozzles have a much lower percent error.
  - **Delevan 2.0 gph error:** 4.09%
  - **Monarch 2.25 gph error:** 13.59%
  - Further testing with different nozzles is ongoing.

- **25 Everloy 2.0 gph-rated hollow cone nozzles** were also tested, and produced results similar to the Delevan nozzles.
Nozzle Clocking Summary

• Monarch nozzles are not uniform around the spray cone periphery
• Delavan nozzles seem to provide more uniform spray pattern through 360° nozzle rotation
  – Delevan flame temperatures are lower (~100°F) than Monarch flame
  – Previously recorded lower temperatures partially due to old thermocouples
  – Temperatures for the Delevan nozzles increased after replacing old thermocouples with new ones
Seat Testing with Burner

- Sonic Burner used to burn seat test cushions using new Delevan and Everloy Nozzles
- Park burner used with Monarch nozzle to test cushions and compared to sonic data
- Sonic burner produced slightly lower % weight loss than Park
- Seat cushions tested in question
  - Different covers used on different foam cushions
  - Need to run test using the same fabric cover on all foam types
Results

![Seat Cushion Weight Loss %](chart)

- **Airflex**
  - Park w/Monarch 80 PLP
  - Sonic w/Delavan AR-D
  - Sonic w/Delavan R-D
  - Sonic w/Delavan B
  - Sonic w/Everloy

- **Dax**
  - Park w/Monarch 80 PLP
  - Sonic w/Delavan AR-D
  - Sonic w/Delavan R-D
  - Sonic w/Delavan B
  - Sonic w/Everloy

- **Fireblock**
  - Park w/Monarch 80 PLP
  - Sonic w/Delavan AR-D
  - Sonic w/Delavan R-D
  - Sonic w/Delavan B
  - Sonic w/Everloy
Summary for Current Meeting

• Ignition Wire Positioning
• Igniter Positioning
• New Stator and Nozzle Settings
• New seat cushion tests with Park and NexGen burners
• Update on thermocouples
Ignition Wires

• Ignition wires previously wrapped around fuel rod
• Not standardized length or position for wires
• Position of wires can impede or redirect airflow within the draft tube and can affect the flame characteristics
Ignition Wires

- New wire length and positions minimize airflow disturbance
- Standardize wire position to minimize variability in burner performance and data results
- Improved repeatability
Example: New Ignition Wire Positions
Igniter Position

- Also needed specific standardized igniter position
- Gap between igniters
  - 1/8”
- Nozzle center to igniter
  - 1/4”
- Nozzle face to igniter
  - 1/8”
Refining Burner Settings

• Same procedure used on cargo burner
• Stator face to turbulator exit plane
  – 2.5”, 2.75” (2 positions)
• Stator rotational position on fuel rod
  – 0-360° in increments of 45° (8 positions)
• Nozzle depth from turbulator exit plane
  – 5/16”, 7/16”, 9/16” (3 positions)
• Total of 48 unique combinations tested
Refining Burner Settings

• Stator/nozzle position combinations were selected which showed adequate flame properties
  – Temperature distribution
  – Repeatability
  – Full, even flame coming from cone (visual)

• Next step, test using seat cushions
Seat Cushion Testing

- New shipment of seat cushions for testing
  - Dax, Airflex, and fireblocked cushions
- All cushions now covered in the same type of fabric
  - Previous tests had different fabrics on different cushion types
- Use Park burner and collect data using new cushions for comparison
Seat Cushion Testing

• Use sonic burner with new initial stator settings to test new seat cushions

• Results less weight loss using sonic burner compared to Park burner
  – Minimal burner on bottom of horizontal cushion

• Stator repositioned to produce a flame that was weighted more on the bottom
Seat Cushion Testing

- Revised stator settings tested
- Results much closer to Park results
- Measured temperature lower, although weight loss % increased
  - Higher measured temperatures do not necessarily mean greater burn lengths and/or weight loss
Seat Cushion Testing

Seat Burner Comparison

Weight Loss Percentage

Cushion Type

- AirFlex
- Fireblock
- Dax

- Park
- Initial Setting
- Revised Setting
Seat Cushion Testing

• Next step is to have other labs setup burner using same settings and check to see if results are comparable
• Nozzle Depth: 3/16”
• Stator Depth: 2 11/16”
• Stator Angle: 0° (centerline from vertical)
Thermocouple Update

• Thermocouple readings drop after repeated heat cycling of the TCs
• Tests run using cargo burner
• Tried larger diameter TCs which have a greater mass, and do not heat as quickly as 1/16” or 1/8” TC
• Results not entirely clear if using larger diameter TCs is an advantage
• Still some signs of temperatures dropping after repeated heat cycling
Future Items

• **Continue testing with possibility of trying other stator settings**
• **Compare results from different labs**
  – Have other labs use new burner settings and test
  – Round robin schedule?
• **Kaowool seat testing**
  – On hold from last meeting do to ignition wire positioning and stator readjustment