Updated Experimental Investigation of the NexGen and Propane Burner

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Project Overview

- **Project Objective:**
  - Quantify the effect of fuel flow rate on burn-through and back side temperature
  - Draw comparisons between the NexGen and Propane burner, for various test article sizes and test conditions.

- **Previously Presented Work**
  - Effect of Burner setup and calibration TC size
  - Sensitivity of Burner to air and fuel flow rates and temperatures
  - Effect of burner orientation on performance
  - Comparison of fire test results between NexGen and Gas burners

- **Recent Developments**
  - Study of Flame Retention Heads (FRH) and Delavan fuel nozzles
  - Burner sensitivity to operating conditions
  - Burner sensitivity to assembly tolerances
  - Sensitivity to inclination and test set-up
  - Study of ignitorless stator configuration, comparison with FRH configuration
Effect of Fuel Flow Rate on Burn-Through and Back Side Temperature
Two fuel nozzles tested:
- Delevan, 80 Degree, Type W, 2.5 GPH
- Delevan, 80 Degree, Type W, 2.0 GPH

Two nozzles were used to reach a larger range of fuel flow rates (1.75 – 2.8 gph) than is achievable from one nozzle alone.
2.5 GPH Nozzle – Flow Rate Variation

- Temperature decreases, as expected, with a decreasing fuel flow rate.
- Burn-Through time increases with a decreasing fuel flow rate, as expected. The trend is not linear.
2.0 GPH Nozzle – Flow Rate Variation

- Temperature decreases, as expected, with a decreasing fuel flow rate.
- Burn-Through time increases with a decreasing fuel flow rate, as expected. The trend is not linear.
2.5 vs 2.0 GPH Nozzle Comparison

- Fuel pressure of different nozzles has an observable effect on performance, regardless if flow rates are equivalent.

- 2.0 GPH nozzle operated at 116 psi
- 2.5 GPH nozzle operated at 65 psi
2.5 vs 2.0 GPH Nozzle Comparison

- **1" Temperature -- 2.25 GPH Flow**
  - Time (sec) ranges from 0 to 2500.
  - The graph compares the time taken for different flow rates.

- **Backside Temperature -- 2.25 GPH Flow**
  - Temperature ranges from 0 to 1500.
  - The graph shows the temperature over time.

- **Burn Through Time -- 2.25 GPH Flow**
  - Time (sec) ranges from 0 to 300.
  - The graph compares the burn through time for different flow rates.

- **2.0 GPH nozzle operated at 142 psi**
- **2.5 GPH nozzle operated at 86 psi**

- **This effect of fuel pressure is repeatable over a range of fuel flow rates.**
Burner operated at same fuel pressure and flow rate.

As a burner cone is ‘broken in’, the fuel flow required to reach 2000 degrees decreases some.
• Burner performance is highly dependent on fuel flow rate. Calibration temperature, back-side temperature rise, and burn-through time are all impacted by fuel flow rate, though the impact is not linear.
• Fuel nozzles of different flow ratings will not perform equivalently, when operated at equivalent fuel flow rates.
• Though burn-through times are not effected by the cone alone, the calibration of the burner (rather, the fuel input required to achieve 2000 F) will depend on the age of the cone.
• Note: A burn-through time of 5 minutes was achieved at fuel flow input of 2.15 GPH (2.5 GPH Nozzle).
NexGen and Propane Comparison
Overview of Set-Up
NexGen Burner: Panel Set-Up

8x8x0.125”

12x12x0.125”

24x24x0.125”
Propane Burner: Panel Set-Up

- 8x8x0.125"
- 24x24x0.125"
- 12x12x0.125"
- 24x24x0.125"
Burnthrough Results
8” Panels

- Flame is fully able to wrap around panel, for both the NexGen and Propane burners.
- When heat flux is matched, NexGen burner takes significantly longer for burnthrough. Likely an effect of gravity (panel is horizontal for vertical propane burner, vs vertical panel for horizontal NexGen).

<table>
<thead>
<tr>
<th>Burner</th>
<th>Temperature (F)</th>
<th>Heat Flux (BTU/ft*s)</th>
<th>Burnthrough (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Propane</td>
<td>2067</td>
<td>9.8</td>
<td>295</td>
</tr>
<tr>
<td>NexGen (55 psi)</td>
<td>1712</td>
<td>9.7</td>
<td>445</td>
</tr>
<tr>
<td>NexGen (100 psi)</td>
<td>1910</td>
<td>13.4</td>
<td>147</td>
</tr>
</tbody>
</table>

![Burnthrough Comparison Chart](image)
8” Panels

Propane Burner

NexGen Burner 55 psi

NexGen Burner 100 psi
• Flame is unable to wrap around for either NexGen or Propane burner.
• When heat flux is matched, NexGen burner takes significantly longer for burnthrough, as with the 8” panels.
• Burnthrough time with the NexGen burner does not increase linearly with increasing fuel pressure.

<table>
<thead>
<tr>
<th>Burner</th>
<th>Temperature (F)</th>
<th>Heat Flux (BTU/ft*s)</th>
<th>Burnthrough (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12” Panels</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propane</td>
<td>2057</td>
<td>9.6</td>
<td>445</td>
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<tr>
<td>NexGen (55 psi)</td>
<td>1696</td>
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<td>908</td>
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<td>NexGen (100 psi)</td>
<td>1909</td>
<td>12.3</td>
<td>143</td>
</tr>
<tr>
<td>NexGen (85 psi)</td>
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<td>11.5</td>
<td>174</td>
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<td>NexGen (100 psi)</td>
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<td>12.3</td>
<td>143</td>
</tr>
</tbody>
</table>
12” Panels

NexGen Burner
100 psi

NexGen Burner
55 psi

Propane Burner
• Flame is unable to wrap around for either NexGen or Propane burner.
• When heat flux is matched, burn-through time with the NexGen burner closely matches that of the propane burner.
24” Panels

Propane Burner

NexGen Burner
Vertical NexGen vs Propane Burner Comparison
Panels were suspended 4” above the burner cone and sandwiched around the edges, exactly as they were using the propane burner.
• Temperature and Heat Flux were matched between both burners as closely as was possible.
• For all test article sizes, the NexGen burner yielded significantly lower burn-through times.
• Note: for both burners, the flame was able to wrap around the 8” panels.

<table>
<thead>
<tr>
<th>Burner (Vertical)</th>
<th>Temperature (F)</th>
<th>Heat Flux (BTU/ft*s)</th>
<th>Burn-Through (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8&quot; Panels</td>
<td>Propane</td>
<td>2067</td>
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<tr>
<td></td>
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<tr>
<td>24&quot; Panels</td>
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<tr>
<td></td>
<td>NexGen</td>
<td>1993</td>
<td>10.8</td>
</tr>
</tbody>
</table>
Post Test Pictures

24x24x0.125”

12x12x0.125”

8x8x0.125”
Summary

- With the larger 24x24” panels, when the heat flux is closely matched, the burn-through performance of both burners is nearly equivalent.
- With both burners operated vertically, and at similar calibration results, the NexGen burner is more severe than the propane burner.