Plasma Ignition and Combustion Stabilization Technology to Improve Flexible Operation, Reliability and Economics of an Existing Coal-Fired Boiler

2021 Spring Review Meeting

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Plasma Ignitor Installation
PacifiCorp Hunter Unit No. 3

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PacifiCorp Hunter Unit No. 3

Agenda

• Market and market drivers for Plasma Ignitor technology
• Technology overview
• PacifiCorp Hunter No. 3 installation
• Testing plan for Hunter
• Expected results
• Project status
• Summary
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Market and market drivers for technology

Steam plant operators experiencing changing market:
- Increased competition with lower cost generation
- Renewables: increased penetration & intermittent generation
- Regulatory pressures
- High cost of auxiliary fuels

Steam plant operators experiencing changing operation:
- Load following
- Cycling operation
- Single or double shifting
- Seasonal variation

Cyclic operation leads to:
- Higher O&M cost with increased off-design
- Increased stresses -> reduced life; increased availability/reliability risk

12 years ago the US Coal-Fired Generating Fleet spent ~ 50% of the time operating above 75% CF. Today, that number has dropped to about 6%.
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Market drivers for technology

Typical Return on Investment
- Low load flame stabilization fuel savings
- Cold start fuel savings

Customer Justification
ROI Elements for customer
- Cost for oil support, 8 hours/day = 2.33 MUSD/Yr
- Costs for coal, 20% MCR vs 35% MCR = 5.10 MUSD/Yr
- Total saving = 7.43 MUSD/Yr

Operating costs
- Cost to operate Plasma Ignitors = 0.162 MUSD/Yr
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Technology Overview

• The system produces a high energy plasma, ~5000°C (ionized gas, air, which is highly electrically conductive) which supports the volatile release and the subsequent volatile ignition. The released volatiles ignite and produces further heat to further fuel de-volatilization. Full flame formation at the burner mouth in the furnace.

• Reducing fuel oil or natural gas consumption for low load and cycling stabilization on coal fired steam generators is a global issue. As renewable energy sources become a larger driving force in the energy market, coal fired units which were previously base loaded are being forced to cycle and operate at reduced loads more frequently.

• The economic benefit for installing a Plasma Combustion Stabilization system can be measured by the reduction in:
  1. Coal consumption
  2. Fuel oil or natural gas consumption
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Installation at PacifiCorp Hunter No. 3

- Located 160 miles southeast of Salt Lake City, Utah
- Rocky Mountain Power HQ located at Salt Lake City, Utah

Unit 3
- 496 MWe (nameplate) coal fired EGU
- B&W opposed wall fired boiler
- Requires oil ignition for lightoff through mill stabilization (40%)
- Experiences frequent load fluctuations from renewables
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Technology Overview

Isometric Showing Installation in Coal Nozzle
Plasma Ignitor Installation
PacifiCorp Hunter Unit No. 3
Installation at PacifiCorp Hunter No. 3
Plasma Ignitor Installation
PacifiCorp Hunter Unit No. 3
Installation at PacifiCorp Hunter No. 3
## Testing Plan for Hunter

<table>
<thead>
<tr>
<th>Boiler Load</th>
<th>&gt;60% MCR</th>
<th>&gt; Min. Permitted w/o Oil Firing</th>
<th>Boiler Start-up with &amp; w/o Oil Firing</th>
<th>One mill operation w/o Oil Firing</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 to 4 Mills in Operation</td>
<td></td>
<td>2 Mills in Operation</td>
<td>2 Mills in Operation (Hot / Warm / Cold)</td>
<td>Mill Nr. 4 in Operation</td>
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<tr>
<td>Bench-marking coal burnout rate w/o Plasma support (Baseline testing)</td>
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<td>XX</td>
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<td>Plasma ignitor position in the burner</td>
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<td>XX</td>
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<td>XX</td>
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<tr>
<td>PC particule fineness, Mill classifier position</td>
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<td>XX</td>
<td>XX</td>
<td>XX</td>
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<tr>
<td>Mill startup with Plasma ignitors (Function check)</td>
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<td>Ignition performance over the mill &amp; boiler load</td>
<td>XX</td>
<td>XX</td>
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<tr>
<td>Influence of plasma supported combustion on NOx &amp; CO emission</td>
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</tbody>
</table>
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Expected results from Hunter Testing

Low load operation:
• Stable ignition of coal down to 25% feeder speed on single mill operation

Cold start capabilities:
• Demonstrate the ability to bring a mill on-line (cold start) without support fuel (oil)

Reduction in fuel oil consumption:
• 80% to 85% reduction in oil consumption
  o Coal start condition
  o Mill transition conditions
  o Low load operation
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Expected results from Hunter Testing
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Project Status

Project schedule:
- Installation – completed
- Commissioning – underway, to be completed Q1 2021
- Host site field testing – to be completed Q1 2021
- Host site summary meeting – Q3 2021
- Project close out meeting – Q4 2021
- Final report – Q1 2022

Project delays due to:
- COVID
- Restricted plant access
- Travel restrictions, etc.
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Summary

Project schedule on tract to be completed – 2/28/2022

Initial operation of Plasma Ignitor system has been successful

Expect testing to be successful:
  • Recent test installation on unit firing EU lignite were successful