Combustion Solutions for Low CO Operation:
CCA Capabilities Overview

Combustion Components Associates Profile

• Leader in Design, Development, Testing and Manufacture of High-Efficiency Low Emission Combustion Equipment

• 20,000 MW of Pollution Compliance Experience

• 100+ Large Utility & Industrial Customers

• 300+ Staff Years of Combustion Experience

• 30 Patents & Patents Pending

• 3 Licensed Technologies

• 20,000 sq.feet Manufacturing Facility

• 45 Employees

Environmental Compliance at the Lowest Cost
CCA Capabilities Overview

CCA Experience

- Burner Modifications
  - 18,725 MW Oil & Gas - 1173 Burners (90 Boilers)
    - 50,000 pph steam to 6,200,000 pph steam
  - 6,915 MW Coal – 550 Burners (42 Boilers)
    - 250,000 pph steam to 6,000,000 pph steam
- OFA & Boosted OFA
  - 6,172 MW (28 Boilers)
    - 250,000 pph steam to 6,200,000 pph steam
- FGR & IFGR
  - 70,000 pph to 4,400,000 pph (13 Boilers)
- SNCR
  - 2,104 MW (20 Boilers)
- SCR
  - 128 Stationary Diesel Engines
  - 20 On-Road & Off Road Diesel Engines
  - 2 wood stokers
- Stokers Three Complete Three in Engineering Phase
## CCA Capabilities Overview

### CO Emission limits, ppm

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<tr>
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<th>Existing Boilers</th>
<th>New Boilers</th>
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<tr>
<td>Biomass Stoker</td>
<td>490</td>
<td>160</td>
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<tr>
<td>Pulverized Coal</td>
<td>160</td>
<td>12</td>
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<tr>
<td>Stoker Coal</td>
<td>270</td>
<td>6</td>
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<tr>
<td>Oil</td>
<td>10</td>
<td>3</td>
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<tr>
<td>Natural Gas</td>
<td>9</td>
<td>3</td>
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</tbody>
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*30 Day Averages*
CCA Capabilities Overview

CO Reduction Techniques

• Testing & Tuning
• Replace Key Parts with New
• Upgrade Key Parts or Systems
  ▪ Atomizers
  ▪ Burners
  ▪ OFA/ Boosted OFA
  ▪ Gas Pokers
  ▪ Coal Spreaders
• Air and Fuel Balance
• CFD Analysis
• CO Catalyst
Testing and Tuning
CCA Capabilities Overview

CO From a Heavy Oil Industrial Boiler

![Graph showing CO emissions vs. boiler load]

- **Stack CO ppm**
- **Boiler Load, MPPH**
- Maximum CO level indicated: 9 ppm
Upgrade Key Parts
CCA Capabilities Overview

Typical Atomizer Flow Characterization

![Graphs showing fuel flow rate with pressure and atomizing differential, atomizing steam mass ratio with fuel flow and atomizing differential, and spray quality with atomizing steam pressure.](image-url)
75 kph Package Boiler

- No. 6 Oil Operation
- Single Burner – Dual Register
- CCA Hardware Change
  - Low NOx Atomizer
  - Staged Flame Stabilizer
- Emissions
  - 25% Reduction in NOx
  - Lower Influence of Fuel Nitrogen (FN)
  - Small (10ppm) Increase in CO
  - Zero Visible Emissions Maintained
  - Opacity up to just under 5% at CO of 40 ppm
**120 kpph Package Boiler**

- Single Burner - Multi-zone counter rotating registers
- Steam atomized No. 6 fuel oil
- Atomizer Change Alone
- NO\textsubscript{X} Emissions (lbm/MMBtu) at 3.5% O\textsubscript{2}
  - 0.325 - Baseline
  - 0.280 - CCA Low NO\textsubscript{X} Atomizers - Config #1
  - 0.260 - CCA Low NO\textsubscript{X} Atomizers - Config #2
- CO Emissions (ppm @ 3% O\textsubscript{2}) at 3.5% O\textsubscript{2}
  - 240 ppm - Baseline
  - 90 ppm - CCA Low NO\textsubscript{X} Atomizers - Config #1
  - 75 ppm - CCA Low NO\textsubscript{X} Atomizers - Config #2
- NO\textsubscript{X} Reductions from Baseline at 3.5% O\textsubscript{2}
  - 14% with CCA Low NO\textsubscript{X} Atomizers - Config #1
  - 20% with CCA Low NO\textsubscript{X} Atomizers - Config #2
Green Wood Chips Stoker
Result of Key Upgrade

Boiler Excess O2, %

- CO
- NOx
- 490 ppm
Air and Fuel Balance
CCA Capabilities Overview

Air And Fuel Balancing

Goals

- Air ± 5%
- Coal ± 10%
- Oil and Gas ± 5%
CCA Capabilities Overview
Air And Fuel Balancing

BENEFITS

• LOWERS LOI
• LOWERS CO
• REDUCES SLAGGING
• LOWERS NOx
• LOWERS OPACITY
• IMPROVES EFFICIENCY
• REDUCES GREENHOUSE GASES
CCA Capabilities Overview

Burner Air Flow Deviations

FLOW DEVIATIONS, %

INITIAL DEVIATIONS, %

FINAL DEVIATIONS, %

BURNER NUMBER

A 1

B 1

C 1

D 1

A 3

B 3

C 3

D 3

-40%

-30%

-20%

-10%

0%

10%

20%

30%

40%
CFD Analysis
CCA Capabilities Overview

CFD Modeling

• Fully optimizes combustion process
• In-depth CCA modeling experience
• Provides basis for final design
• Ensures it will work when installed
CCA Capabilities Overview

EXISTING OFA PORTS

- 5000 ppm CO
- ISOSURFACE
5000 ppm CO ISOSURFACE
COMPARISON OF UPGRADES

Upgrade
Independent Operation
SW Corner Modification
Upper Aux Air Port Mod
Corner Fuel Biasing
Catalyst for CO
CCA Capabilities Overview

SCR views

165 kpph Boiler

220 kpph Boiler