Overview of Low NOx Burners
Presented by Stéphane Laurin, Ing.
Sales Manager, Canada
Energy Solutions Center
Low NOx Boiler Workshops
November 2002

Outline
- NOx Theory Review
- NOx reductions methods
- Low NOx burners
  - DAF
  - Delta NOx
  - QLN
  - QLA
  - ULN

NOx Comparison Table

<table>
<thead>
<tr>
<th>Capacity</th>
<th>CCME / Policy A-9 NOx</th>
<th>Houston NOx</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;10 MMBtu/hr</td>
<td>0.02 #/MMBtu</td>
<td>0.01 #/MMBtu</td>
</tr>
<tr>
<td>10-100 MMBtu/hr</td>
<td>0.06 #/MMBtu</td>
<td>0.015 #/MMBtu</td>
</tr>
<tr>
<td>10-40 MMBtu/hr</td>
<td>0.06 #/MMBtu</td>
<td>0.036 #/MMBtu</td>
</tr>
</tbody>
</table>

Factors affecting Thermal NOx
- Firing rate
- Furnace size
- Furnace type (refractory, front wall construction, etc.)
- Air preheat
- Excess air

Fuel NOx
- Formed during the combustion of fuels containing bound nitrogen
- Typical fuels with bound nitrogen:
  - No. 6 oil & residual oils
  - Coal
  - Gases containing ammonia

Reducing NOx
- Identify the major NOx contributor
  - Apply the proper technique in relation to the reduction objective
**Flue Gas Recirculation**

**Advantages:**
- Very effective at reducing thermal NO\(_x\) on gas and light oils
- Minimum effect on flame length
- Reasonable excess air throughout firing range
- Easily added to any boiler installation
- Can be combined with other low NO\(_x\) techniques

**Disadvantages:**
- Increase in mass flow through boiler - higher system losses
- May require review of superheater design for possible effects on steam temperature

---

**Steam Injection**

- Reduces flame temperature by adding mass at cool temperature, similar to FGR
- Cheaper to install than FGR lines
- Involves a de-rating of the boiler
- Decreases dew point of stack flue gases
- Will tend to shield flame from scanners

---

**Fuel NO\(_x\)**

- Approaches to reducing Fuel NO\(_x\)
  - Create fuel rich zone - very little O\(_2\)
  - Slow mixing of secondary air to complete combustion
  - Primary zone residence time > .2 seconds

---

**Spray Staging**

**Performance Considerations**

**Operational:**
- Maximum Firing Rate
- Turndown
- Stability
- Repeatability
- Reliability

**Emissions:**
- NO\(_x\)
- Fuel
- Thermal
- CO
- Particulates
- Opacity / Smoke
The NOx - CO Loop

- NOx Decrease cause CO Increase
- CO Increase require Temp Increase
- Temp Increase cause NOx Increase
- NOx Increase require Temp Decrease

DAF burner

Delta NO\textsubscript{x} burner

Delta NOx Burner

QLN Burner

- Fuel Staging & Premix Design
- \(< 76\) ppm w/o FGR
  - Boilers w/ High SHRR
  - \(< 30\) ppm w/o FGR
  - Boilers w/ Low SHRR
  - \(< 30\) ppm w/ FGR
- In Most Package Boilers

QLN Flame
QLA Ultra Low NOx Burner

QLA Flame

QLA Design Concept
- Variable Air Zone Geometry For Improved Turn Down
- Separate Core Zone For Improved Flame Stability
- Secondary Gas Spuds For Improved Performance
- Pre-Mix Primary Fuel Zone for low Prompt NOx

Typical Ultra Low NOx Performance

• <0.01 Lb/mmBtu NOx
• Stable Combustion
• High Turndown
• Very Low CO
• Low Excess Air
• Multi-Burner compatible

QLA Burner Performance

Benefits of QLA with FGR
Design Concept – ULN

Central air augmented zone for axial stabilization

Annular air augmented zone for radial stabilization

Design Concept – ULN

Fuel Staging & Furnace FGR

Benefits of ULN Technology

- High Turndown
- Flexible Performance
- 0.015 – 0.03 Lb NOx/MMBtu
- Wide Flame Stability
- Simple Controls
- Robust Operation
- Refinery Gas Compatible

Coen’s New ULN Burner

Low NOx Solutions in Package Boilers

- 76 ppm - “Delta-NOx” with No FGR
- 49 ppm - “Delta-NOx” with No or Minimal FGR
- 49 ppm - “QLN” with No FGR
- 20 ppm - “QLN” with Minimal FGR
- 12 ppm – “Delta-NOx ULN” with FGR
- < 9 ppm - “QLA” with FGR