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Company Profile

- Privately held, incorporated in 1979
- 250-acre facility in Broken Arrow, OK
- Specialists in the design and manufacturing of combustion equipment
Zeeco’s Global Presence

Installations in over 62 Countries
46 International and 20 Domestic U.S. Locations
500+ Total Employees • 300+ Engineering & Design Staff
Valero Corpus Christi emission reduction project goals

- Retrofit existing boilers with low emission technology
  - NO$_x$ < 0.03 lb/MM Btu HHV
  - CO < 50 ppmv at 3% O$_2$ dry
  - UHC / Particulate / VOC < 15 ppmv at 3% O$_2$ dry
- Minimize installation costs
- Minimize operating costs
- Minimize maintenance costs
Boiler 132-B-1 / B-2

- Two (2) boilers relocated from ship to plant site
  - Two burners per boiler
  - 75 MM Btu/hr per burner
  - 17’ H x 8’ W x 14’ D
  - 78,782 Btu/ft³ volumetric heat release
  - Ambient air
  - Brick lined outer wall
- Refinery fuel gas
  - (730-2919 Btu/scf LHV)
  - with up to 40 mol% H2
NO$_x$ Emissions vs Peak Flame Temperature
Fuel Reconditioning for Lower Thermal NO$_x$

- Simple design for a complex problem.
- The fuel gas is mixed with inert products of combustion before combustion occurs, thus "reconditioning the fuel gas".
Traditional Burner Stabilization

- The Free-Jet concept is similar to conventional burners which uses a tip next to a ledge to stabilize a gas/air mixture on a refractory tile ledge.

Figure 2: Traditional Burner Stabilization Technique.
Free-Jet Design Advantages

- Stable flame over a wide range of conditions
- Compact design makes this burner a great choice for retrofit applications
- Compact flame shape
GLSF Free-Jet Boiler Burner
Gas Tip Comparison

- Shown left: A standard low NO$_x$ gas tip that may have as many as six ports including very small ignition or “stability” ports.

- Shown right: Patented Free-Jet gas tip with a single port design—no small ignition ports required.
Low-Maintenance Gas Tip Design

- Free-Jet has 68% less exposed tip area

<table>
<thead>
<tr>
<th>Tip Area (in²)</th>
<th># of Tips</th>
<th>Total Exposed Tip Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zeeco Free-Jet</td>
<td>1.309</td>
<td>32</td>
</tr>
<tr>
<td>Competitor</td>
<td>16.04</td>
<td>8</td>
</tr>
</tbody>
</table>

Some designs expose the risers as well to radiant heat.

Typical Standard Gas Tip

Free-Jet Tip
Single-firing port, no ignition ports required.
Free-Jet Burner

Due to the compact design and flame shape of the Free-Jet burner, the burners can be retrofitted into applications where other Next Generation Emission burners cannot be installed.
**Traditional Burner Stabilization**

The Free-Jet concept is similar to conventional burners which uses a tip next to a ledge to stabilize a gas/air mixture on a refractory tile ledge.

*Figure 2: Traditional Burner Stabilization Technique.*
Free-Jet Stabilization

As the oxygen content in the boiler is reduced, the flame front moves from the tile’s 1st stabilization ledge to the 2nd stabilization ledge. At high excess oxygen levels, the flame stabilizes on the 1st ledge like a conventional burner flame stabilizes on a refractory tile ledge, without the sweeping effect from combustion air flow.
Considerations during the retrofit

- Accurate & complete data from existing operation for retrofit design
- Boiler tramp air leakage addressed
- Combustion air forced draft fan controls
- Steam into fuel not required for NO\textsubscript{x} control
- Maximize use of available air pressure drop
- Reuse existing windbox and fuel gas train
Tramp Air Leakage
Tramp Air Leakage
Conclusions

- Challenging retrofit due to age of boilers
- Lack of accurate design data
- Tramp air leakage had to be addressed
- No external FGR required
- Steam into air stream ~ 0.3 – 0.4 # steam / # fuel
- Met emission guarantees for NOx (<0.03 lb/MM)
- Met emission guarantees for CO (<50 ppmv)
Zeeco Free-Jet Applications

- Zeeco Free-Jet Burners have now been installed in over 300 furnaces and boilers.
- First installation started up in 2000
- Maintenance free design
- They are used in the following types of services:
  - Cabin furnaces, vertical cylindrical furnaces, cokers, ethylene crackers, reformers, OTSG’s, boilers, and incinerators.
Thank You

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