Heater & Burner Tuning

Lower Emissions & Improve Equipment Life

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Heater Draft Profile

Draft = -0.1” wc

Draft = -0.6” wc

Draft = -0.4” wc

Draft = 0” wc

ROT = 0.10” wc / ft of radiant box height
Draft Measurement

Draft Gauges
The inclined tube type manometer is the most common gauge used for draft measurement.
Draft Target

- **Heater designer / Manufacturer determines the target draft for each heater design**

- **Typically this target is 0.05 – 0.10” wc at the arch**
Draft Implications

**Draft too high**

- Elevated stack temperatures
- Tramp air ingress

**Draft too low**

- Firebox damage
- Safety for Ops personnel
Heater Inspection

• Flame Stability / pattern
• Refractory condition / color
• TMT’s / tube hanger color
• Burner gas tips / tile condition
Combustion vs. Thermal Efficiency

Combustion Efficiency
% of completion of the combustion reaction

Thermal Efficiency
Function of Stack temp and Excess Air
% O₂ vs Excess Air

1% O₂ = 5% excess air
2% O₂ = 10% excess air
3% O₂ = 15% excess air
4% O₂ = 20% excess air
5% O₂ = 25% excess air
Excess Air Target

- 1-2% O2 target range (5 – 10% excess air) for gas fired heaters

- However this depends on:
  - Fuel gas composition
  - Mechanical condition of equipment
  - Heater service / swings
Burner / Heater Adjustment

When making adjustments to the heater a visual check of burner flame quality should be made and the heater allowed to reach new equilibrium prior to any further adjustment.
Excess Air Adjustment

Stack damper is for heater draft adjustment

Burner register is for excess air adjustment
Natural Draft Heater Adjustment Flow Chart

Start

Check Draft

Check O₂

On Target

High (1)

Close Damper

Return to Start

Check O₂

On Target

High (3)

Close Damper

Close Air Registers

Return to Start

Low (2)

Open Damper

On Target

High (3)

Close Air Register

Open Damper

Return to Start

Low (3)

Open Air Registers

Open Air Registers

Return to Start

Good Operation

Target Draft

Target O₂

(1) High Draft means fire box press. more neg. than target.
(2) Low Draft - means fire box press. more pos. than target.
(3) Low or High O₂ means O₂ is above or below target.
Fuel Efficiency

% Oxygen in Flue Gas

% Excess Air in Flue Gas

% Fuel Loss

% O₂ to % Excess Air Ratio

Stack Temperature
- 1400° F
- 1200° F
- 1000° F
- 800° F
- 600° F
- 400° F

% Oxygen in Flue Gas

% Excess Air in Flue Gas

Stack Temperature
- 1400° F
- 1200° F
- 1000° F
- 800° F
- 600° F
- 400° F
Excess Air Reduction Savings

40MM Btu/hr fired htr w/ 800F stack temp @ 7.5% O2
Excess air reduced to 3% O2
~5% of the fuel is used to heat ambient air to 800F
~$6/MMBtu fuel cost
~$200,000 in fuel savings / yr
Excess Air
Automated Control
Excess Air Reduction Savings

40MM Btu/hr fired htr w/ 800F stack temp @ 7.5% O2

Excess air reduced to 3% O2

~5% of the fuel is used to heat ambient air to 800F

~$6/MMBtu fuel cost

~$200,000 in fuel savings / yr

~$15,000 for jackshaft & actuator
Tramp Air Leakage Sources

- Sight Ports
- Convection section flanges / header box
- Explosion doors
- Open air registers on burners Out of service
Tramp air leakage
Tramp Air Leakage remedies

• Sight Port Covers
• High temp sealant caulk
• close air registers on burners Out of service
Tramp Air reduction savings

Sight port 4” X 6” 800F stack temp @ 0.50” wc draft loss

~2300 #/hr ambient air being heated to 800F

~$6/MMBtu fuel cost

~$21,400 in fuel loss / yr
Heater Sight Port Cover

High temperature glass covered heater sight port

Cost ~$500
Savings ~$20,000
Tramp Air -- NOx Impact

Tramp air leakage (as % of total air flow) vs. NOx emissions

~10% air leakage increases NOx emissions 15-20% range*

~20% air leakage increases NOx emissions 30-40% range*

(*depends on where the tramp air is introduced)
Burner Maintenance
Burner Inspection

• Gas tips / risers
• Burner tile
• Pilot tip and mixer
• Air register / damper
Consistency is the goal
Consistency is the goal
Burner Maintenance
Burner Maintenance

SLOPED FACE OF GAS TIP TO POINT TOWARD CENTER OF BURNER (TYP.)

1/2" EXPANSION JOINT (NOT BY ZEECO INC.)

TILE VIEW
Burner Maintenance

SINGLE PORT DRILLED
5" O.V. AWAY FROM FLAT

3/32"

TOWARD CENTER OF BURNER
Burner maintenance

Fuel Pressure Vs. Heat Release Curve
Tile inspection

Inspect the tile for cracks and missing pieces. Replace the tile if any of the pieces are broken or missing.
Pilot Inspection

Inspect the pilot tip for any damage. The pilot air door for operability and the pilot orifice for plugging.
Pilot Inspection

Pilot shield should normally glow cherry red, shields are consumable parts.
Air damper / register inspection

Ensure that the air control damper or register operates freely and is properly engaged.
Diffuser cone inspection

Inspect diffuser cones or swirlers for damage. Replace if damaged.
Gas tip inspection

Example of a gas tip which has failed due to coking of condensed heavy or unsaturated hydrocarbons inside the tip.
Gas tip Inspection

Check that orifice sizes match the sizes shown on the drawing, when any orifice becomes one drill size larger than specified, replace the orifice/tip.

<table>
<thead>
<tr>
<th>DRILLING NOTES</th>
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<tbody>
<tr>
<td>PILOT MIXER ORIFICE DRILLED: #50 Ø</td>
</tr>
<tr>
<td>INBOUND GAS TIP DRILLED:</td>
</tr>
<tr>
<td>9 TIPS DRILLED WITH (1) 1/16&quot; Ø F.P. DRILLED AT 15° O.V. PER PA-795</td>
</tr>
<tr>
<td>OUTBOUND GAS TIP DRILLED:</td>
</tr>
<tr>
<td>23 TIPS DRILLED WITH (1) #39 F.P. DRILLED AT 5° O.V. PER PA-841</td>
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Gas tip port orientation

5 degree Port Orientation

15 degree Port Orientation
Gas Riser inspection

Gas Riser failure due to exposure to radiant firebox
Gas Tip / Riser Fouling problems it creates
How Zeeco can Help

• **Onsite burner / maintenance school** tailored around the burners at your plant

• **Heater survey / inspection report**

• **Pre-turnaround inspection**

• **Low cost spares / refurbished Burner and components (rather than complete replacements)**
Spares savings

• For typical sized GC refinery, Zeeco can supply equal or better quality combustion spares at about ½ what you are currently paying.

• For typical refinery this amounts to about $200,000 per year savings just in spares.
Summary

• **Lower emissions via heater draft control, tramp air control, excess air control**

• **Improve equipment life via active “Look & Act” plan, clean, refurbish, replace components as needed. Get burner vendor as a maintenance partner**
Zeeco Field Support

NOT JUST EQUAL – BETTER