



## CASE STUDY: THE CUBL-CF COMPACT FLAME BURNER

Environmental and Combustion Experts

**Honeywell**  
**UOP**

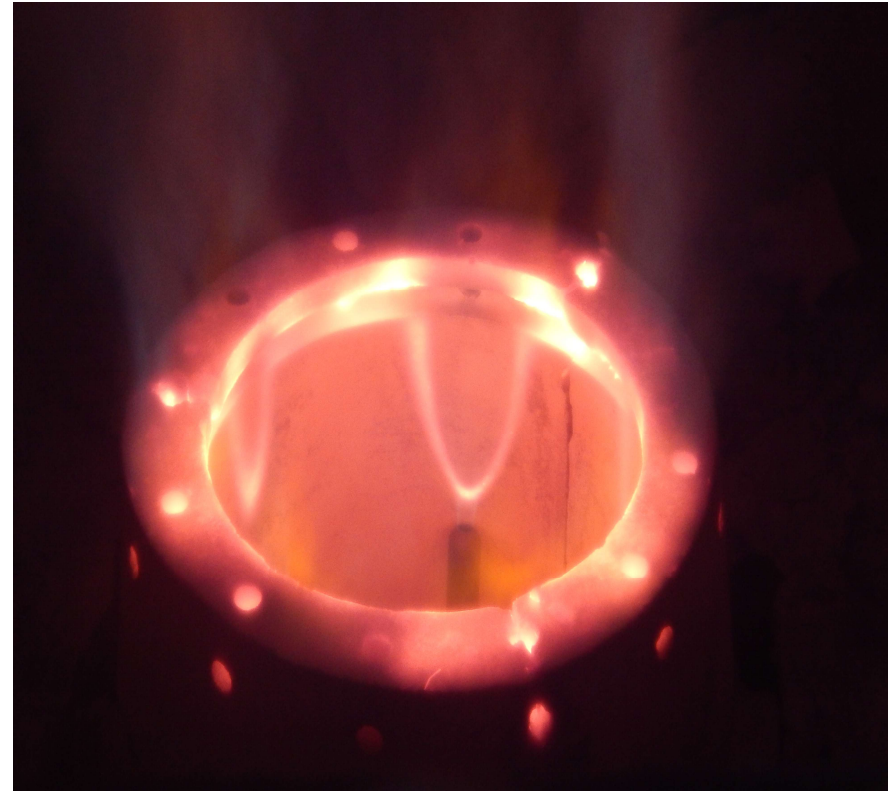
Callidus  
Technologies

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# Customer Have Told Us What is Wanted From Burners

- Operates Like a Conventional Burner

- Low NOx Emissions
- One Air Control Handle
- One Fuel Control Point
- Conventional Draft / O2 Control / Response
- No Startup Lances, Special Procedures
- Not Reliant on Pilot For Stability
- 10:1 Turndown
- Accepts Widely Varying Fuel
- As Stable as a Conventional Burner (90% Stoichiometry)
- Compact Flame
- Not Susceptible to Plugging/Fouling



**Customers Want a Plug and Play Burner**

# The CUBL Series of Ultra Low NOx Burners

## CUBL

With specific requests and developmental mandates from the industry's leading companies, the CUBL was designed to require no special operating needs, ability to fit into virtually any application, shorter flame lengths and is extremely stable. The result is a burner with improved NOx reduction and reduced maintenance.

## CUBL-X NEXT-GEN BURNER

The CUBL-X burner uses a series of primary combustion air inductors designed to maximize the amount of air that is introduced into the primary combustion zone of the burner. This added technology provides outstanding performance for furnaces with low-draft operations, short radiant box heights, and tight burner-to-burner spacing or internal currents that prove to be a challenge for other burner technologies. This advanced technology gives the CUBL-X its ability to produce 40% more heat capacity compared to other burners that require larger heater floor cut-outs.

## CUBL-DF DOWN FIRED BURNER

The CUBL-DF takes the proven CUBL technology one step further, incorporating the use of separate manifolds to fire PSA or off-gases. The results are incredibly low NOx levels. Additionally the improved exit velocity from the CUBL-DF tile minimizes the flame leaning that can sometimes occur in a down fired reformer. We have supplied thousands of down-fired CUBL-DF burners for reformers in hydrogen, ammonia and methanol service.

## CUBL-F FLAT FLAME BURNER

Designed for cracking and coking furnace applications, the CUBL-F flat flame process burner is suitable for firing up a wall, across the floor or free standing in the furnace. The CUBL-F provides superior mechanical safety and integrity, flame quality and does not require special operating needs while delivering optimized heat flux profiles and ultra-low NOx emissions.

## CUBL-HC HIGH-CAPACITY BURNER

The CUBL-HC burner takes advantage of the CUBL technology and applies it in high capacity, forced draft situations. In these applications, large heat releases are required and there is additional need for shorter flames than traditional ultra-low NOx burners. Utilizing the high airside pressure drop available on most high heat release, forced draft projects, the CUBL-HC yields ultra-low NOx emissions and compact flames.

## CUBL-CF COMPACT FLAME BURNER

Ideal for retrofits into existing tight refinery furnaces, the CUBL-CF Compact Flame Ultra Low-NOx Burner provides an economical solution that combines low emissions, shortened flame lengths, ease of installation and is low maintenance. The result is reduced NOx emissions, increased fired duty of the furnace, and improved throughput in the refinery.

Adapted for General and Specific Applications

# Filling In the Customer Requirements Matrix

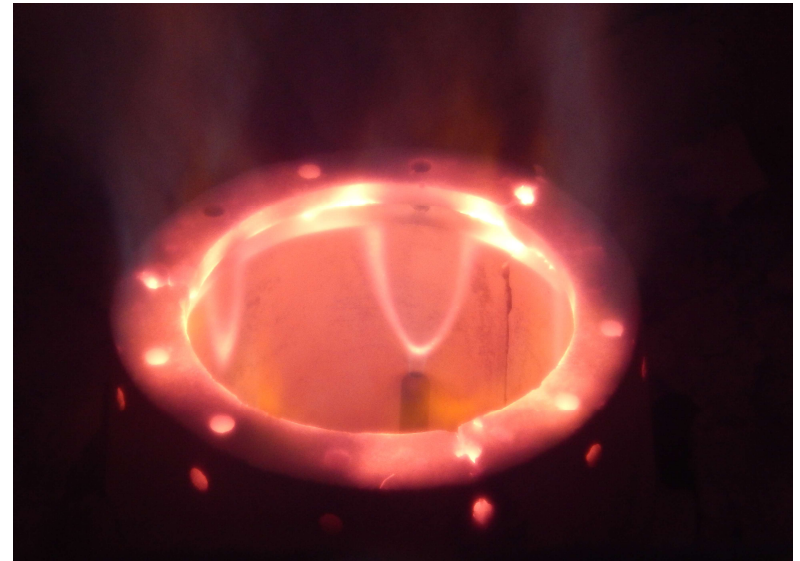
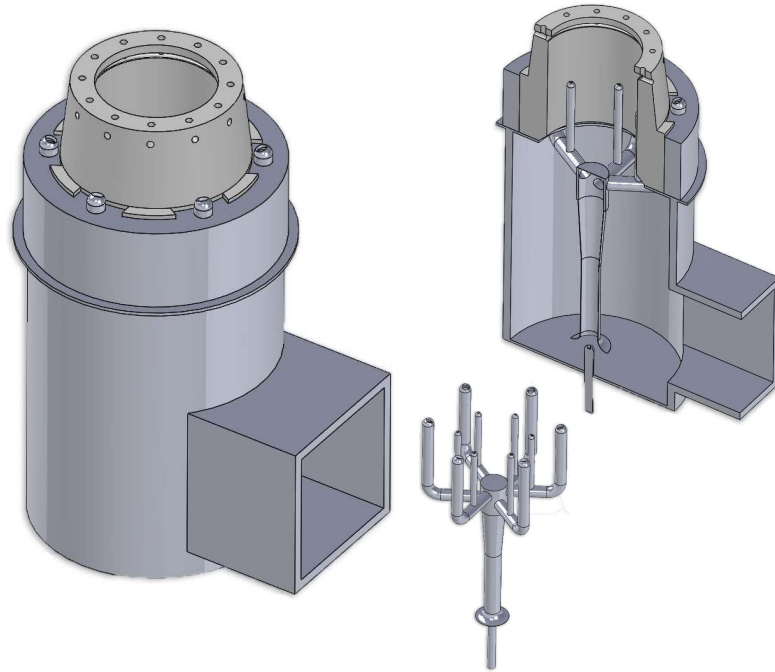
	CUBL	CUB-LX	CUBL-DF & HC	CUBL-F	CUBL-CF
Low NOx Emissions	?	?	?	?	?
One Air Control Handle	?	?	?	?	?
One Fuel Control Point	?	?	?	?	?
Conventional Draft / O2 Control	?	?	?	?	?
No Startup Lances	?	?	?	?	?
Not Reliant on Pilot For Stability	?	?	?	?	?
10:1 Turndown w/ or w/o Air Adjustment	?	?	?	?	?
Accepts Widely Varying Fuel	?	?	?	?	?
As Stable as a Conventional Burner	?	?	?	?	?
Compact Flame		?	?		?
Not Susceptible to Plugging/Fouling					?

**The CUBL Series Has Covered Most of the Bases**



# Callidus CUBL-CF

Compact Flame Ultra Low-NO<sub>x</sub> Burner - Commercial Application of Off-Stoichiometry Partial-Premix for Process Burner Applications by Utilizing Staged, Rich Partial Premix, Internal Flue Gas Recirculation

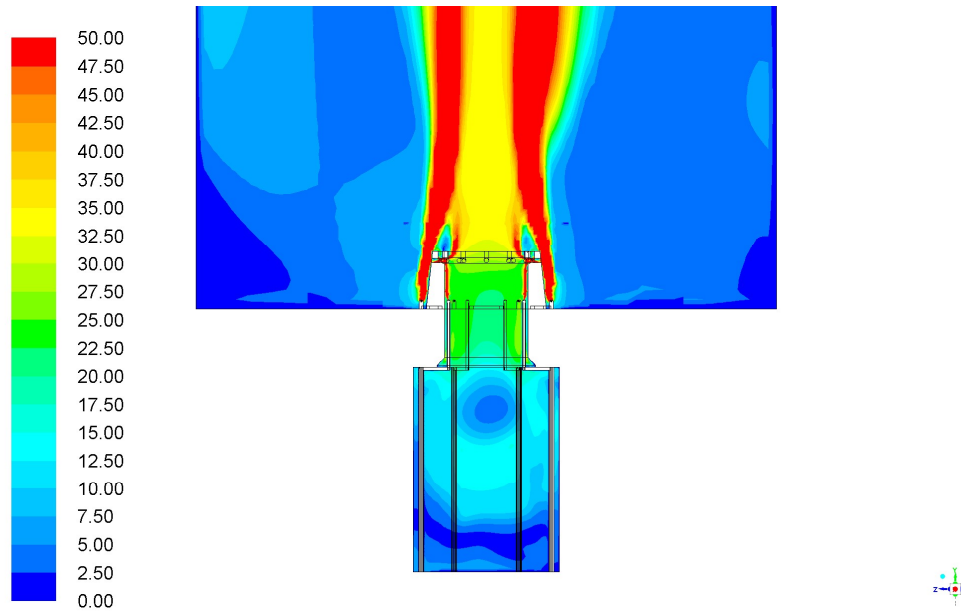


- Born from Trusted and Proven Technology: Basic elements are the same as the Conventional Callidus CUBL burner.
- Uses the Same Tile, Same Tip Arrangement, Same Cavity Stabilization
- Developed by Extensive Physical Testing and CFD Simulation

**Patent Pending Staged, Rich Partial Premix Internal Flue Gas Recirculation**

# Callidus CUBL-CF

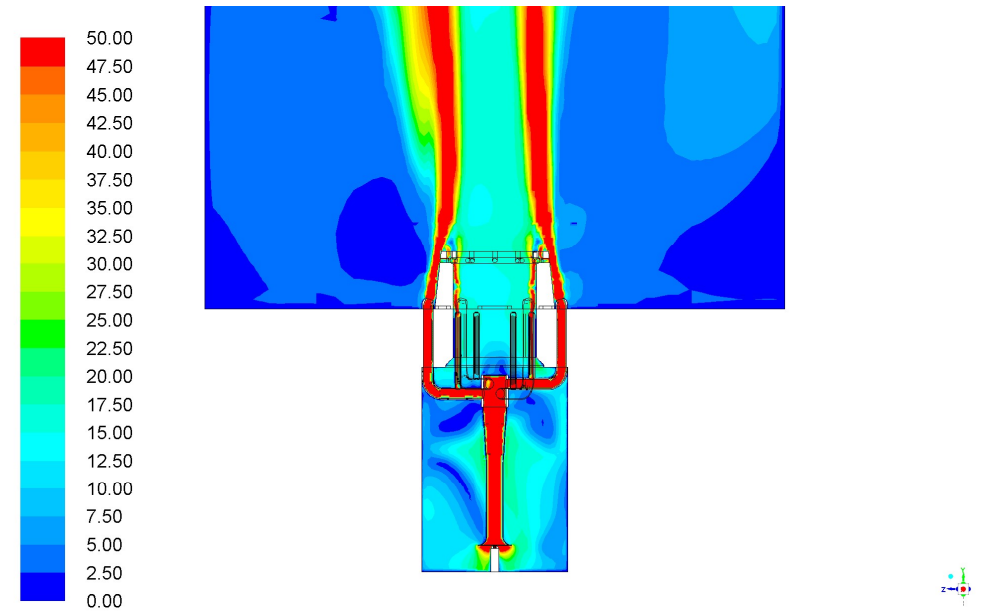
Compact Flame Ultra Low-NOx Burner - Commercial Application of Off-Stoichiometry Partial-Premix for Process Burner Applications by Utilizing Staged, Rich Partial Premix, Internal Flue Gas Recirculation



Contours of Velocity Magnitude (ft/s)

Aug 01, 2016  
ANSYS Fluent Release 17.0 (3d, pbns, spe, rke)

Conventional CUBL Burner



Contours of Velocity Magnitude (ft/s)

Jul 18, 2016  
ANSYS Fluent Release 17.0 (3d, pbns, spe, rke)

CUBL-CF Burner

**Patent Pending Staged, Rich Partial Premix Internal Flue Gas Recirculation**

# The CUBL-CF Checks The Remaining Boxes

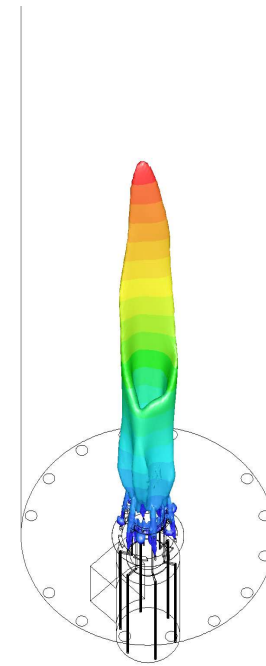
- Accepts Widely Varying Fuels
  - One Port Drilling for All Fuels
  - No Special Natural Gas Drilling, No NOx Hit
  - No Flashback on Hydrogen to over 90%
  - Flame Cavity Stabilized Away from Staged or Primary Tips
- Stable as a Conventional Burner
  - No Special Natural Gas Drilling
  - Stable Sub-Stoichiometric Operation, No Flashback
- Not Susceptible to Plugging or Fouling
  - One Large Fuel Gas Port ~ 1/8"
  - Gas Port in Cool Location Away from Heat Affected Zone
  - Primary and Staged Premix Ports > 3/4" Diameter, Not in Flame
  - Easy to Clean – Steam It Out

**Patent Pending Staged, Rich Partial Premix Internal Flue Gas Recirculation**

## Shorter, More Compact Flame

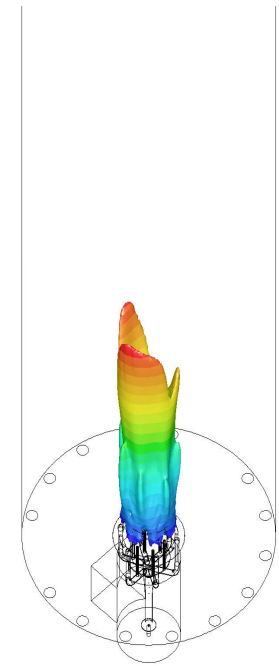
	Conventional Premix	Early Generation Ultra Low NOx	CUBL	CUBL-Compact Flame
Flame Length	1	2	1.5	1.2
Burner Cutout	1	2	1.25	1

- Same Entrainment Length of Conventional CUBL for Primary and Secondary
- Roughly Same Momentum, So Similar Flue Gas Mass Entrained and Recirculated Internally
- 100% of fuel and less than 50% of Air is Premixed
- Air Entrainment Increases Burner Air Capacity
- Allows Use of Smaller Burner Tile for Same Fired Capacity



0 6.56168 (ft)

Conventional  
CUBL  
Burner



0 6.56168 (ft)

Compact Flame  
CUBL-CF  
Burner

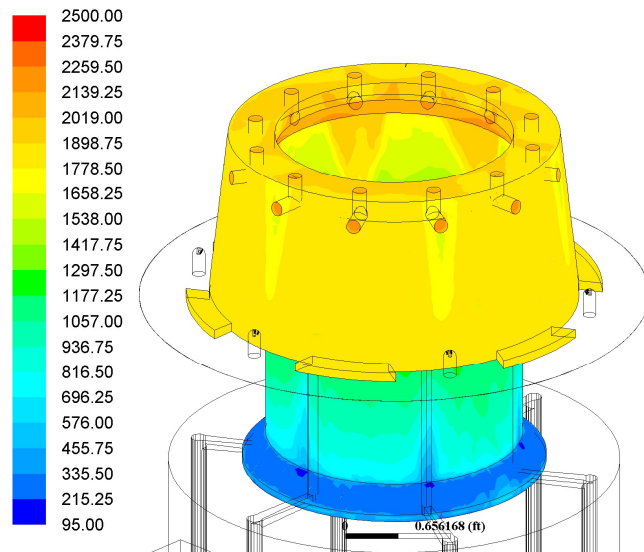
**Patent Pending Staged, Rich Partial Premix Internal Flue Gas Recirculation**



## Added Benefit – Everything Runs Cooler

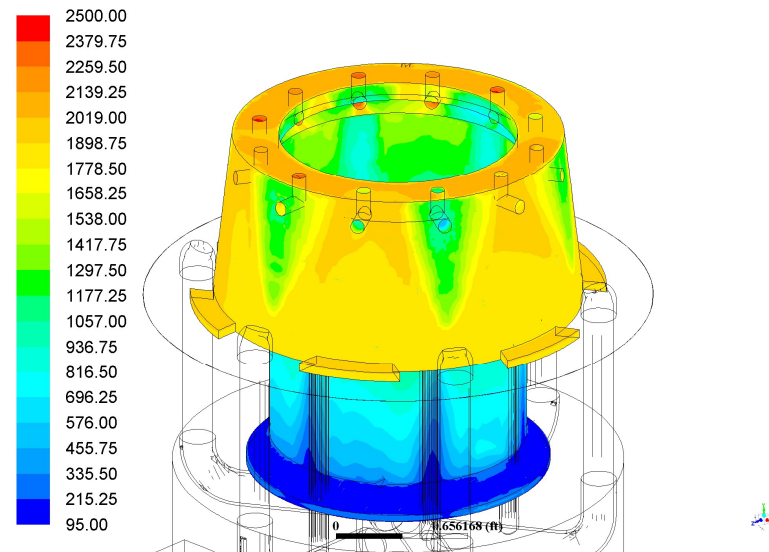
- Increased Equipment Lifespan Reduced Service:

- Gas Tip Less Prone to Plugging
- Not In Heat Affected Zone
- Easy to Pull The One Gas Tip



Conventional CUBL Burner

- Burner Head Uses Same CUBL Bullet Tip Design
- Risers Are Heat Exchangers Transfer Heat To Fuel/Air
- Cool Burner Head Manifold Can Be Steamed Out



Compact Flame Low-NOx Burner

Lower Temperatures Where it Matters

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Jesse Chambers	Brian Yeates	Kurt Kraus
	Albert Septiano	

**READY TO SUPPORT YOUR OPERATIONAL NEEDS**



Callidus Burner School  
October 6, 2020  
Kurt Kraus  
Virtual, online, everywhere

## Case study: The AERO Radiant Wall Burner

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## Cracking Furnace operational environment

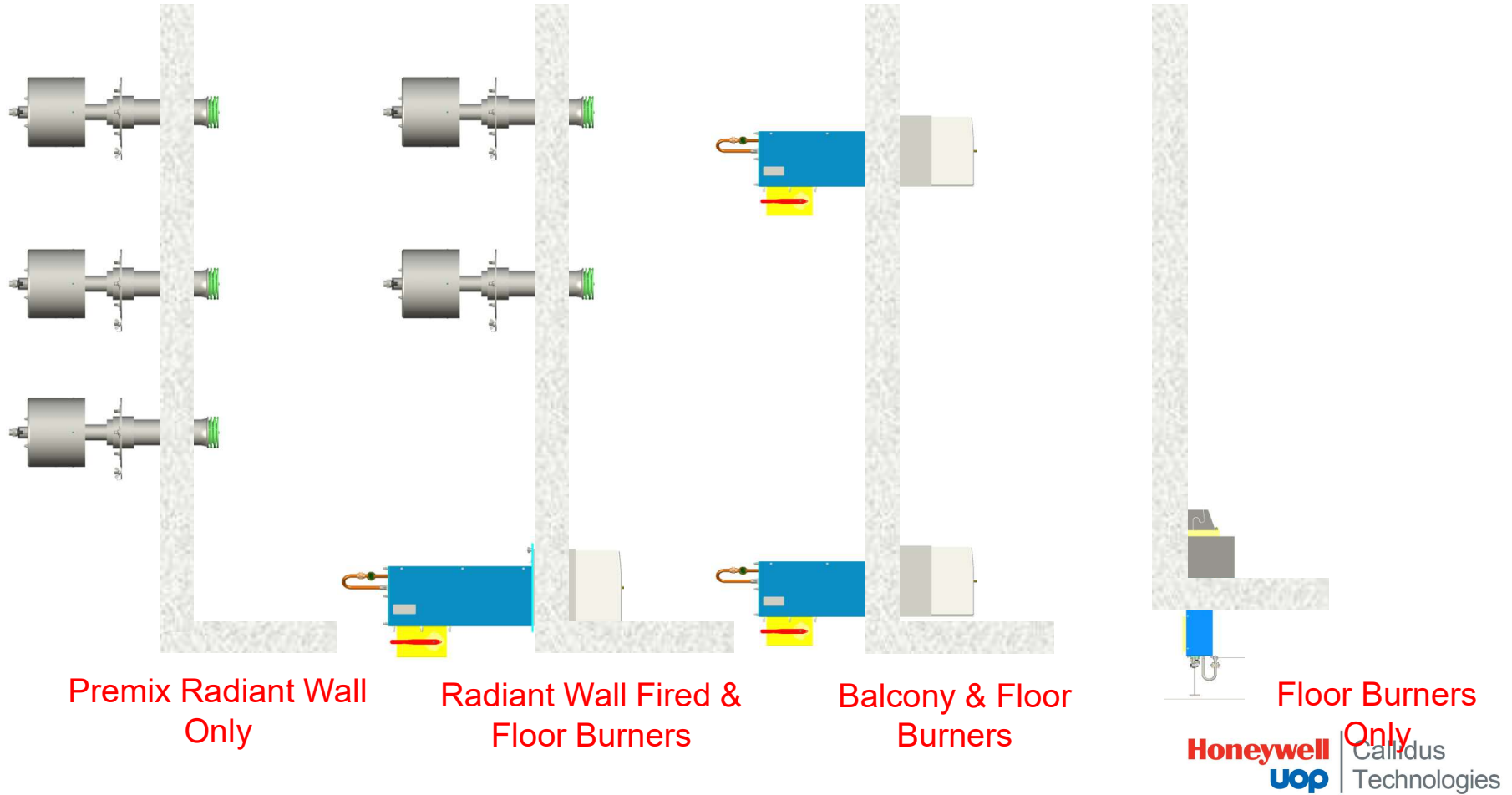
- Must produce even heat flux along wall
- Flames must lay against wall
- Components must withstand 2200 to 2300 degree F. operating temperature
- Maximize run times between de-coking
- Produce Low NO<sub>x</sub>
- No special operating requirements



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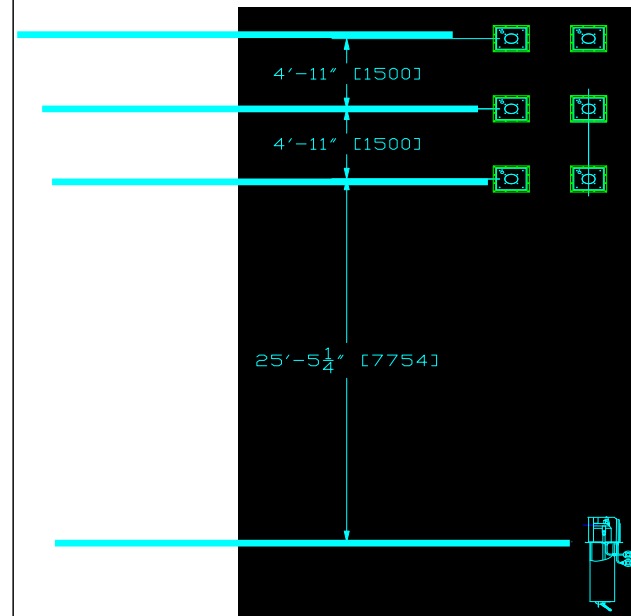
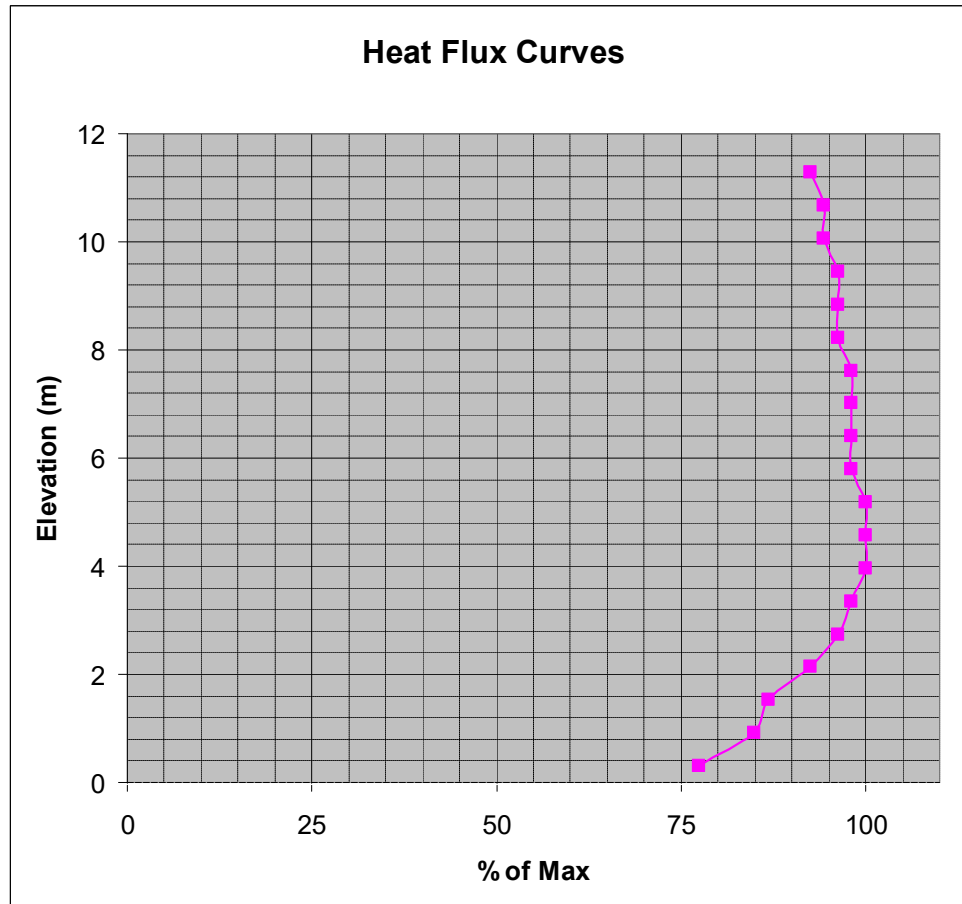
# Most Common Cracking Furnace Burner Arrangements






# Test Furnace Heat Flux

2 ~ Hearth Burners & (70% H.R.) & 6 ~ Radiant Wall Burners (30% H.R.)



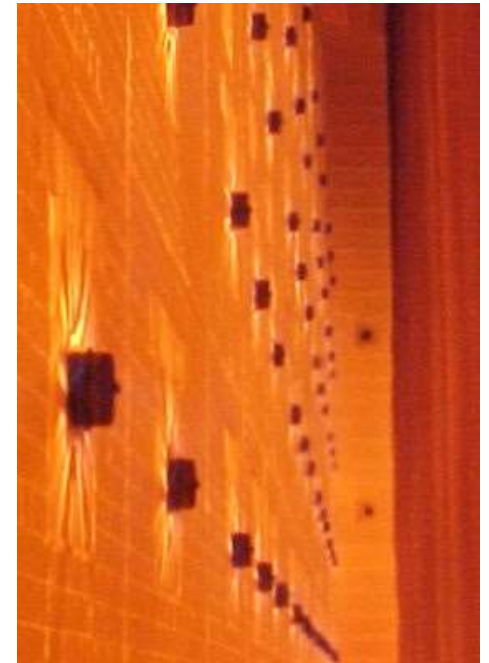
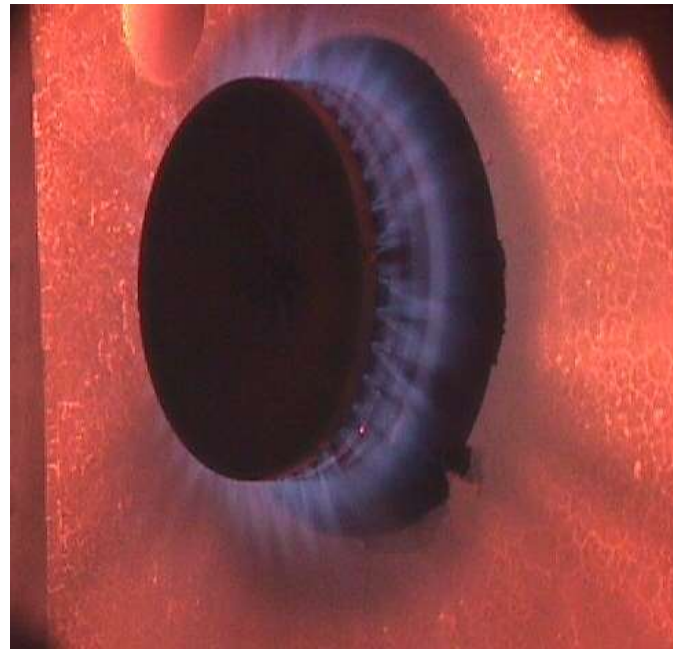


Premix Burners  
(Radiant Wall Burners)

Floor Burners  
(Hearth Burners)

# Premix Burners for cracking furnaces

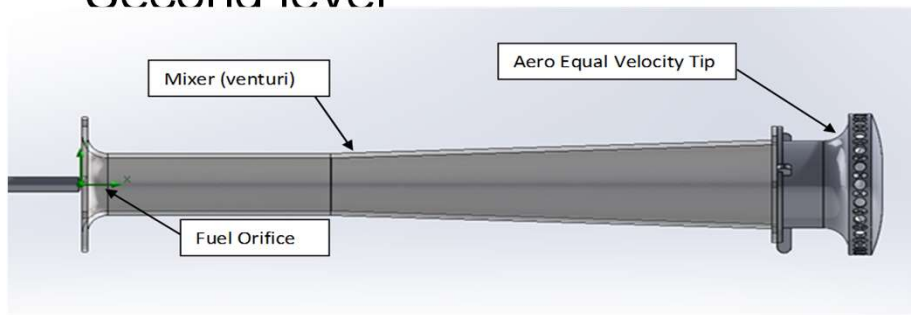
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# Premix Burner components

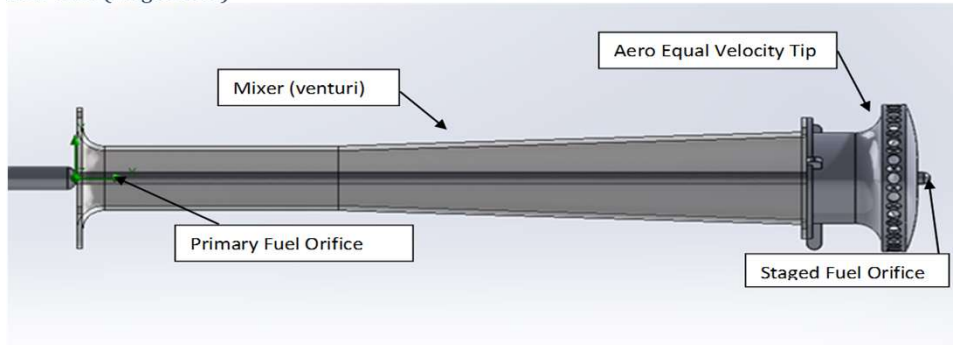
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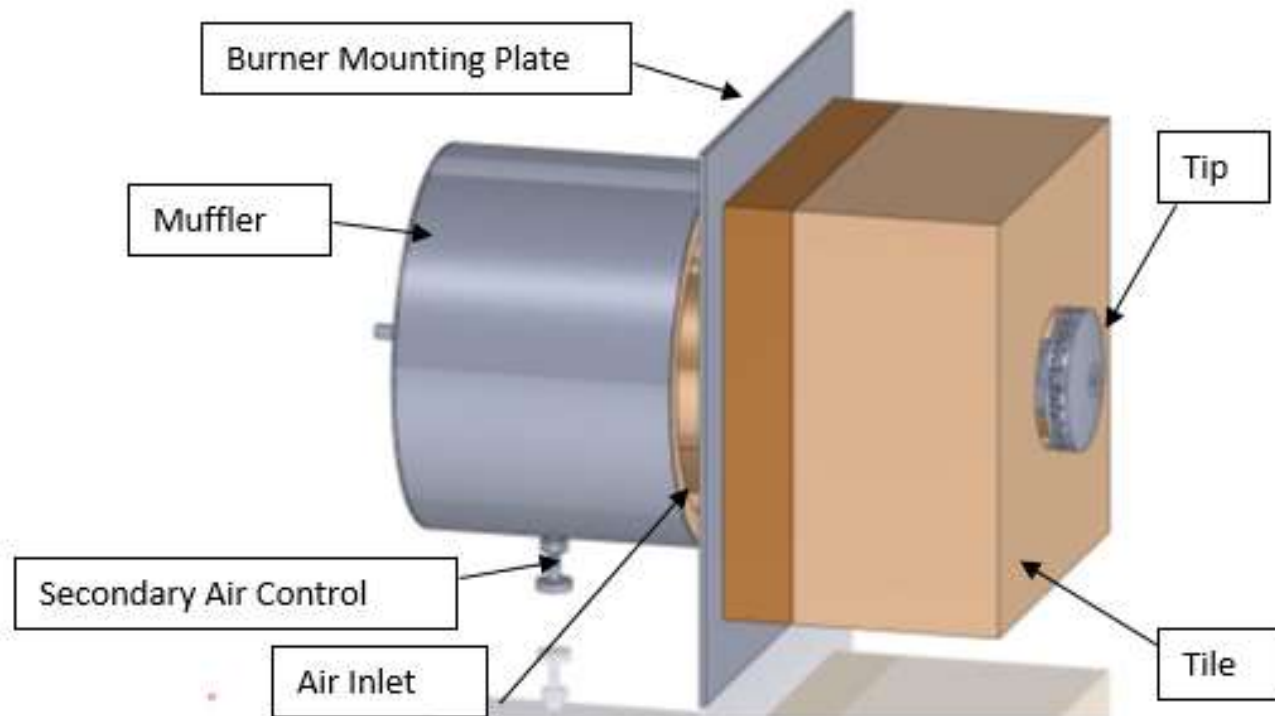
In conventional premix combustion, the fuel and air are completely mixed before they are discharged into the combustion zone.

Low NOx (staged fuel)



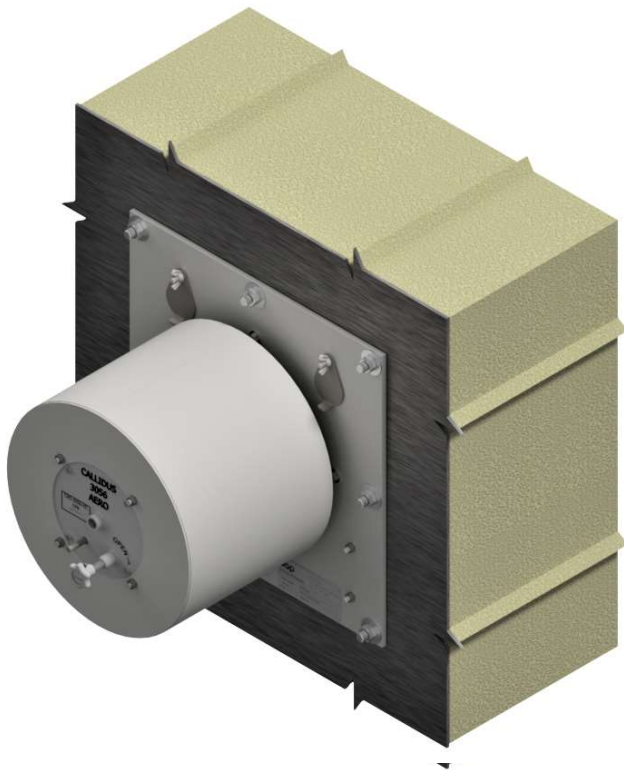
With Low NOx stage fuel premix combustion, a portion of the fuel (primary) and all air are completely before they are discharged into the combustion zone (Lean Premix). The balance of the fuel is staged and injected into the heater in a manner in which flue gas is mixed with the fuel prior to combustion.

## Aero™ Premix Burner radiant wall burner

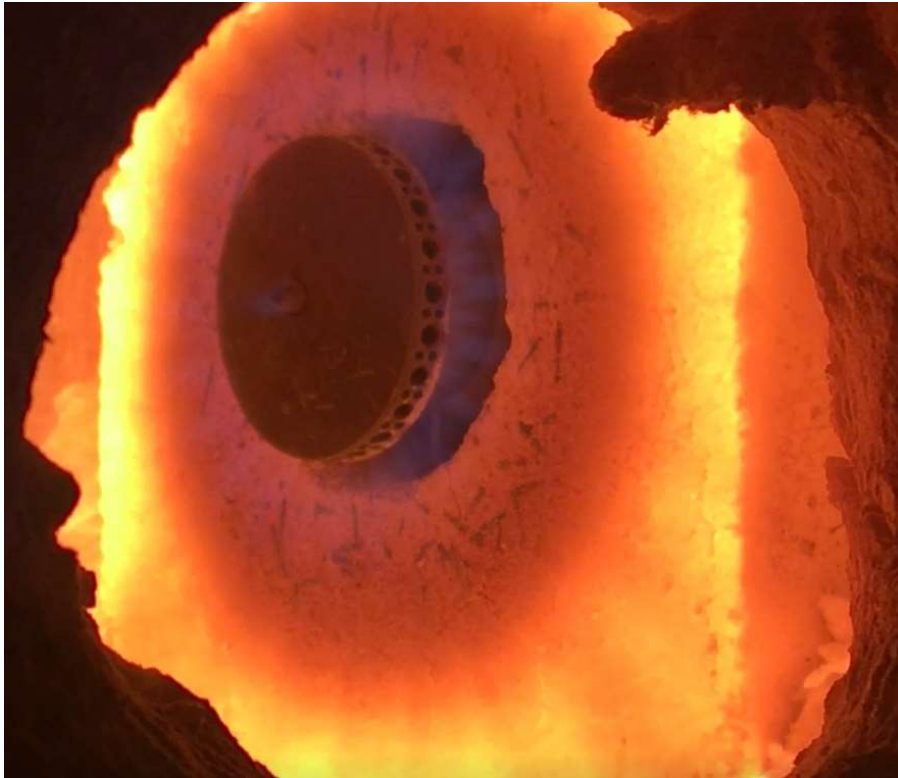




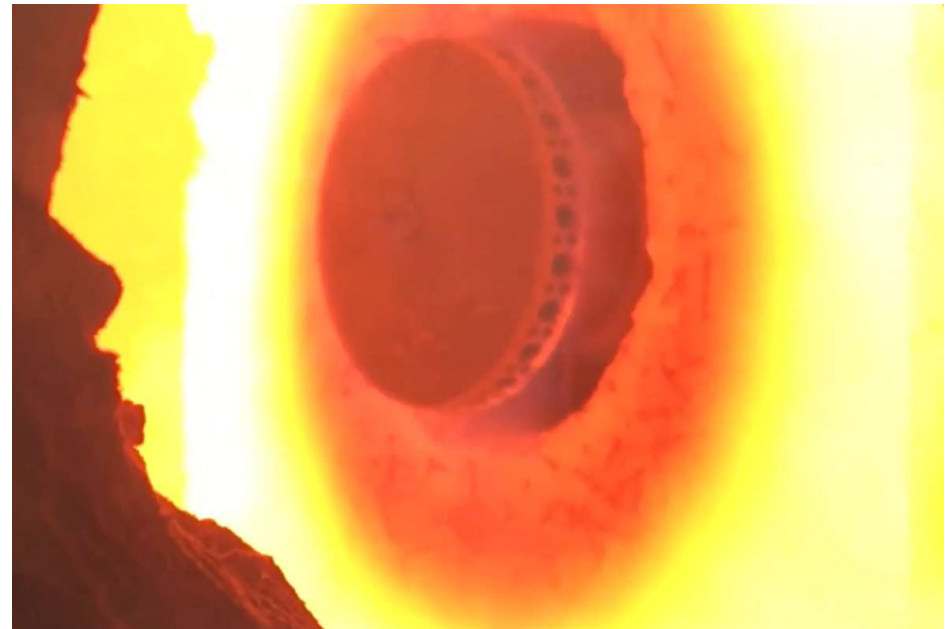
## AERO™ Burner Details



## AERO BURNER IN Operation



**Normal 70%H<sub>2</sub> Fuel Gas**



**100% Hydrogen**

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