Get the Most from Your Coker Heaters

REFCOMM®
MUMBAI
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By

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Furnace Improvements

Existing Heaters

- Two Identical Units– Each w/Twin Box Horizontal Tubes - Double Fired and Twin Convection Sections
- 4 pass arrangement - 2 passes per Radiant / Convection
- Residual + Natural Recycle Feed
- Design tube skin temperature-1250 °F

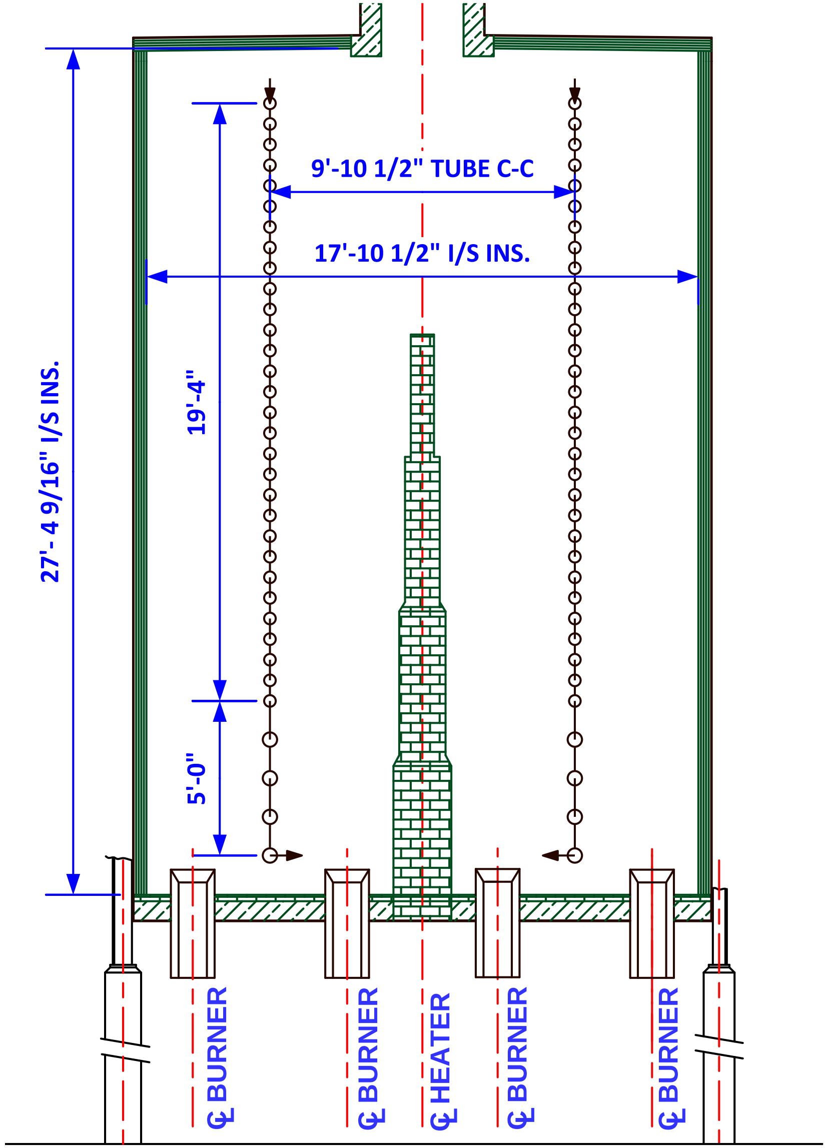
Existing Radiant Sections

❖ Twin Radiant Cells

❖ Total number of Tubes per Cell: 68

- Arranged in 2 Rows and 2 Passes
- Each Pass Separated by FQFB Gravity Wall

Parameter	Top 30 tubes	Bottom 4 tubes
Tube Size	4” NPS Sch.120	5” NPS Sch. 160
Tube Material	A335 Gr P9	
Effective tube length	61’-0”	61’-11 ½”
Tube C-C Spacing	8”	15”
Heat Transfer Area	5,046 ft^2	

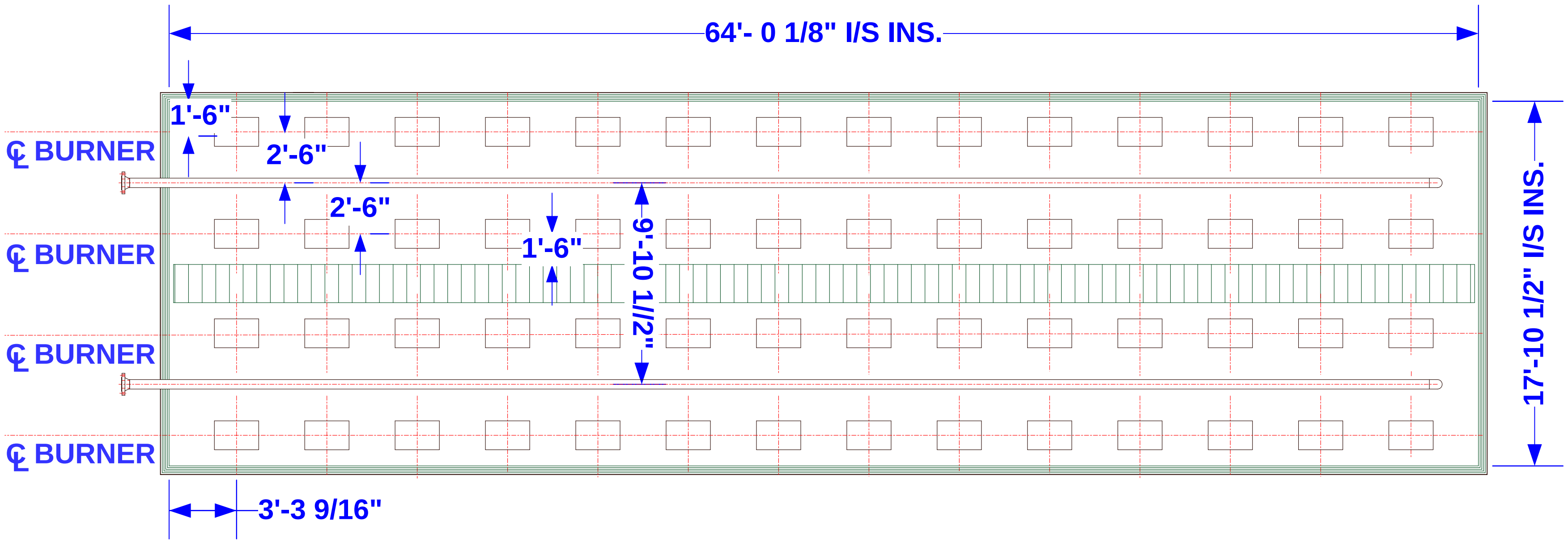


Existing Burners

❖Double Firing with 4 rows of burners in each cell
- Natural Draft, 15% Excess Air
- Low NOx, Fuel Gas Fired

❖56 flat flame burners in each radiant cell

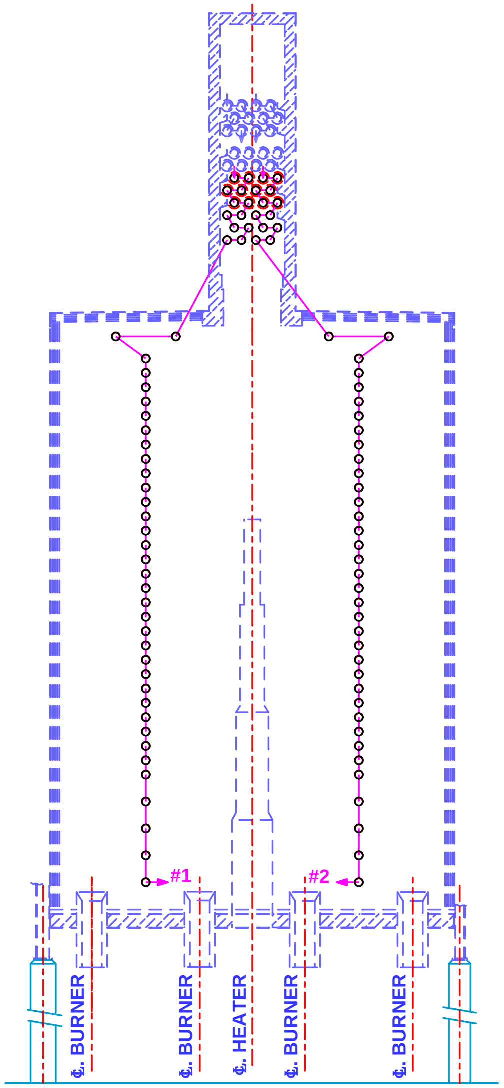
❖Heat Release
- Max.: 2.09 MMBtu/hr
- Normal: 1.67 MMBtu/hr



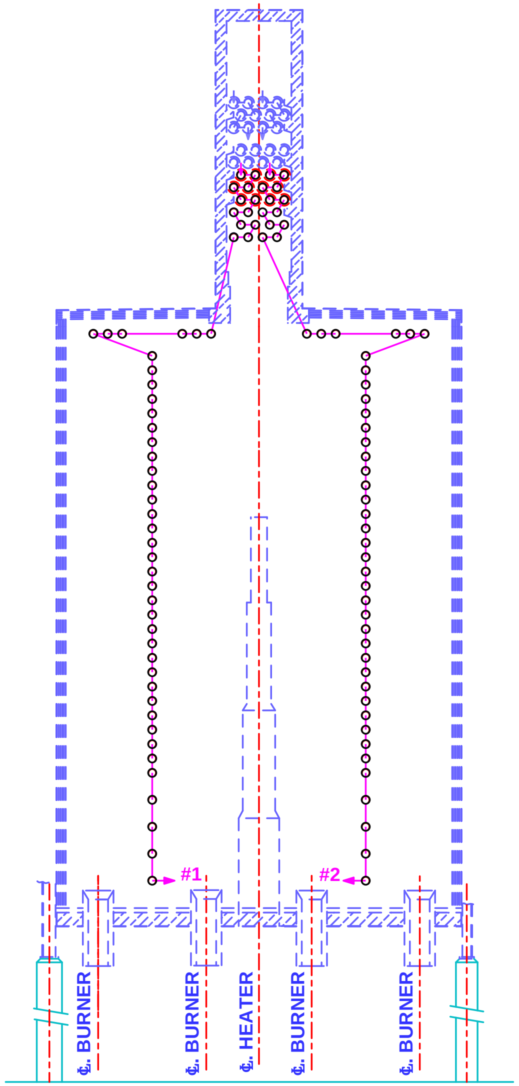
Existing Heaters – Operational Issues

- Flame Impingement on Radiant Tubes
- Heat Maldistribution and Excessive Heat Flux Density
- High Tube Metal Temperatures
- Short Heater Run Length

Proposed Options



Option-1



Option-2

- ❖ Replace last four radiant 5” NPS Sch.160 coils with six 4” NPS Sch.120
- ❖ Upgrade Radiant and Convection coil metallurgy to A312TP347H
- ❖ Option-1: Two tubes of 4”NPS Sch. 120
- ❖ Option-2: Six tubes of 4”NPS Sch. 120
- ❖ Option-3: Addition of new 4” NPS Sch.120 coils installed in convection future rows provision

Benefits of Proposed Options

- Increase in Process Fluid Mass Velocity for bottom tubes
- Reduction in Inside Film Temperature
- Reduction in Tube Metal Temperatures
- Reduction in Relative Coking Rate

Benefits of Proposed Options

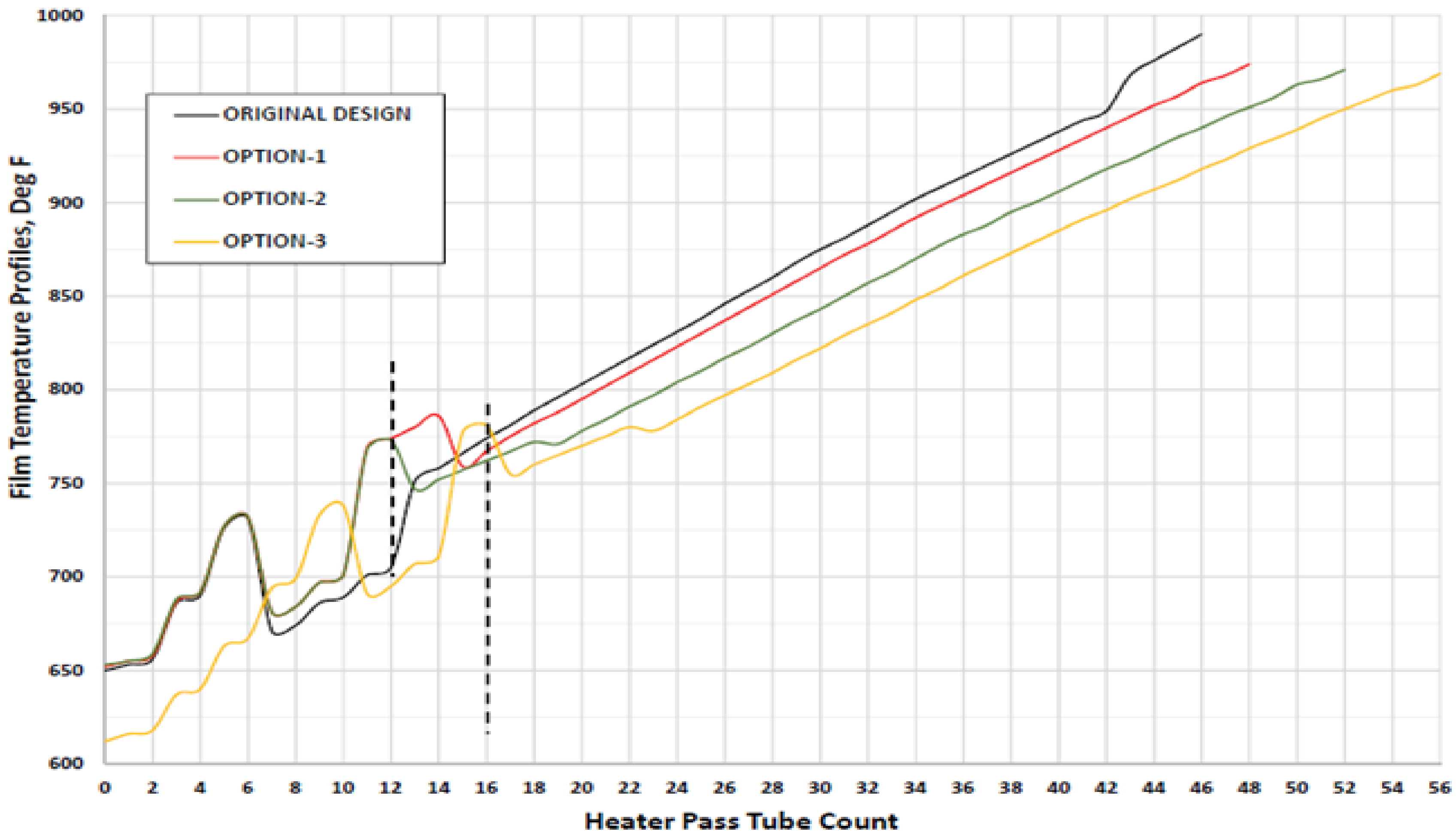
Parameter	Design	Option-1	Option-2	Option-3
Radiant Heat Flux Density (Btu/hr.ft^2)	11,000	5% Reduction (10,450)	19% Reduction (8,910)	25% Reduction (8,250)
Maximum TMT (°F)				
Arch Tubes	-	964	908	905
30th Tube	1,059	1,058	1,051	1,043
Outlet Tube	1,100	1,075	1,066	1,057
Reduction in Firing Rate		3%	3%	8%

Pressure Drop Comparison for Proposed Options

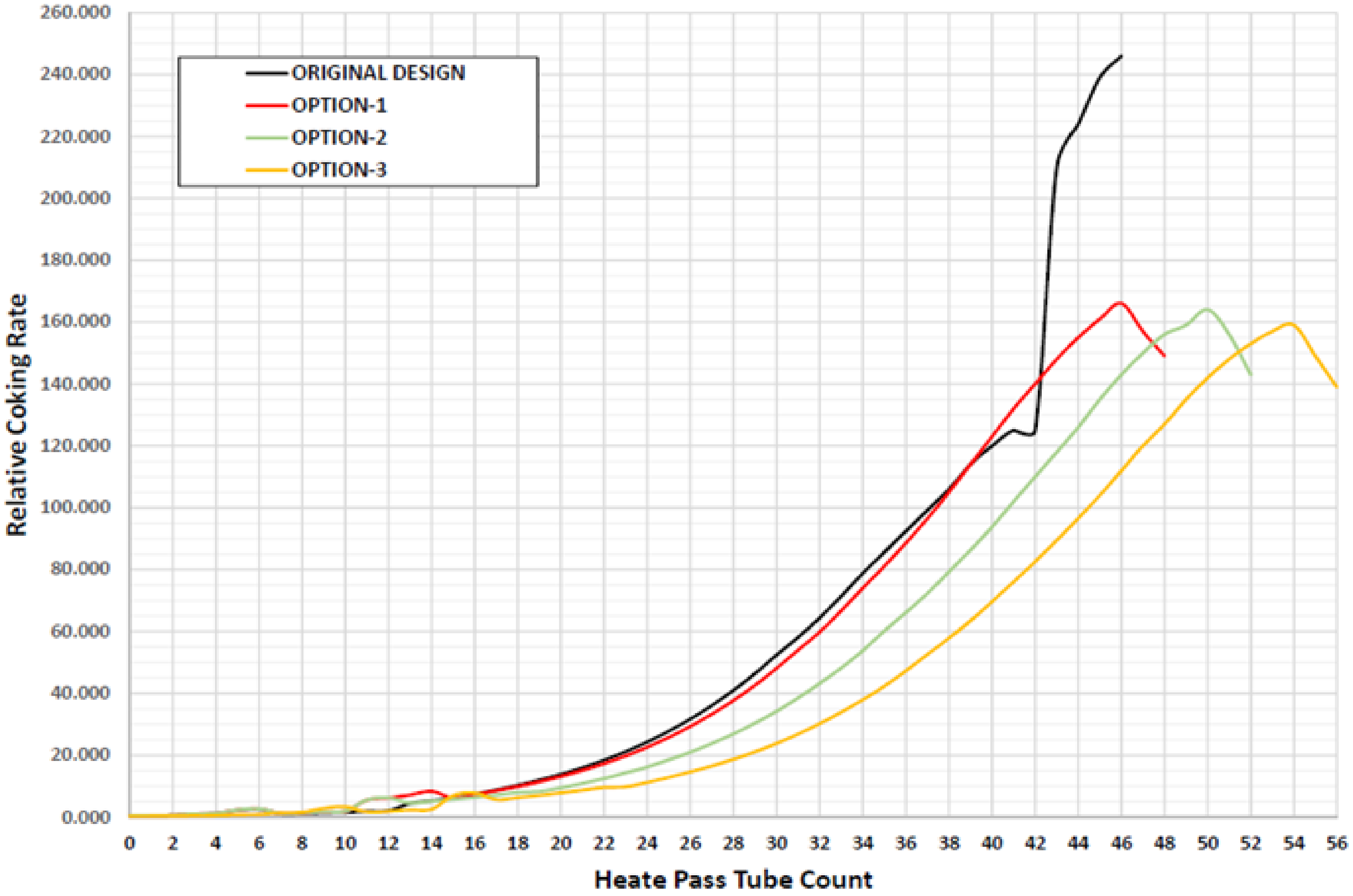
❖ Current Operation, psi	290 – 310
❖ Option 1, psi	342
❖ Option 2, psi	365
❖ Option 3, psi	383
❖ Design Pressure Drop, psi	390

The pressure drop can be reduced if needed by using lower thickness tubes or by increasing OD of the tubes.

Film Temperature Profiles



Relative Coking Rates



Comments

- ❖Significant benefits by adding more tubes in the radiant section and lowering the heat flux, coking rates and film temperatures

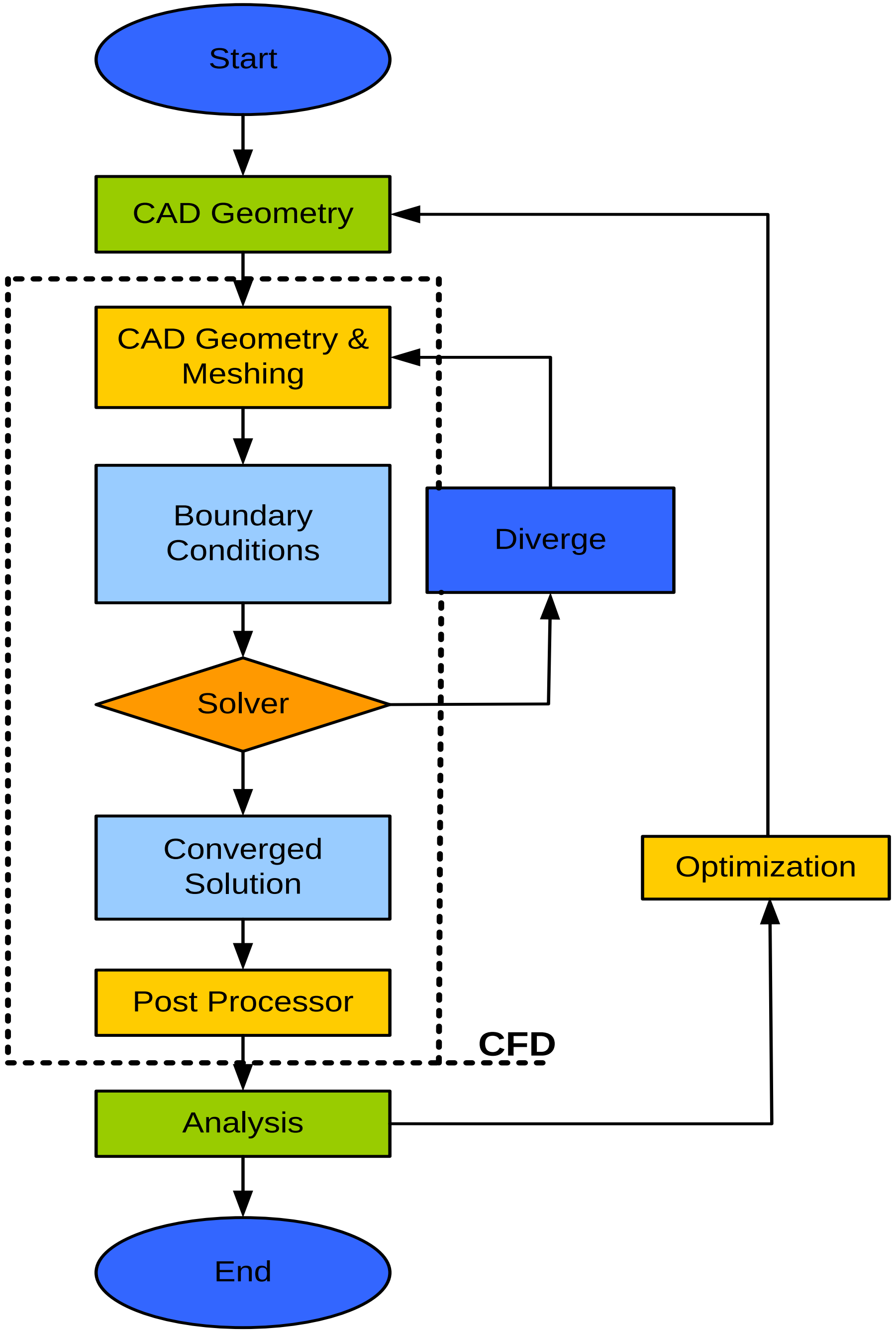
- ❖Significant savings are possible by lowering the tube thickness in radiant and convection section

- ❖Huge fuel savings as required firing rate is reduced

Burners

- 112 burners in each heater
- Flat flame, ultra low NOx, Up-fired
- Fuel LHV=1,026 BTU/scf

- 2.09 MMBtu/hr Design Heat Release
- Natural Draft

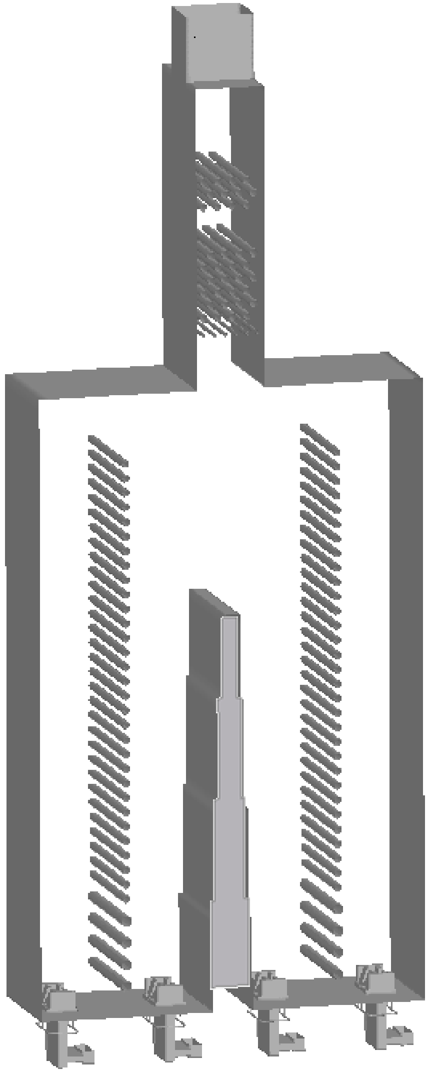


Methodology Flowchart of CFD Modeling

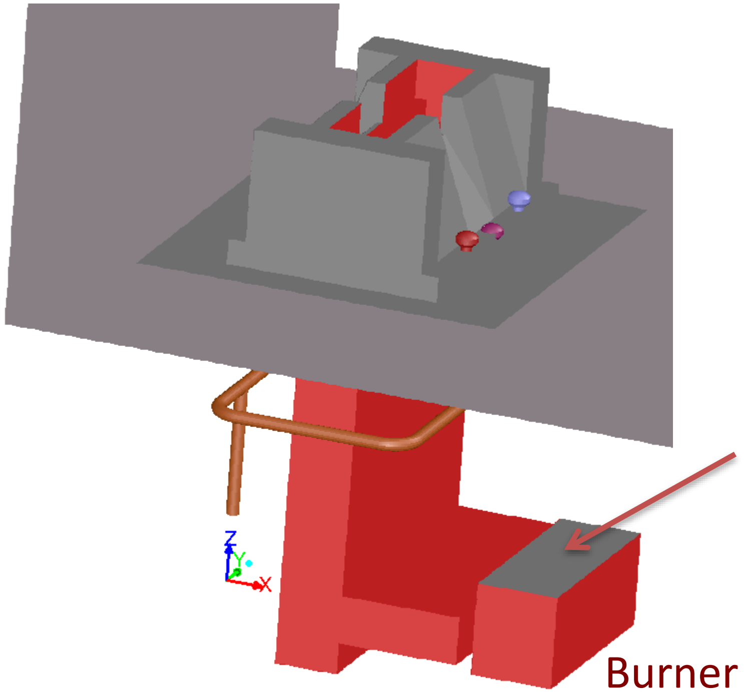
Operating Data for Modeling

Coker Heater 2					
Parameters	**Units**	**Pass 1**	**Pass 2**	**Pass 3**	**Pass 4**
Charge Rate	BPH	425	420	410	424
Fuel Gas Flow	scfh	53,038	52,321	44,039	54,490
Fuel gas Pressure	psig	12.9	12.8	9.9	14.1
Excess O_2 in Flue Gas	%	2.44	3.05	2.83	2.49
Heat Release/Burner	MMBtu/hr	2.27	2.26	1.89	2.33
Total Fuel Gas Flow	scfh	106,235		99,392	

Heater Geometry



Heater Geometry

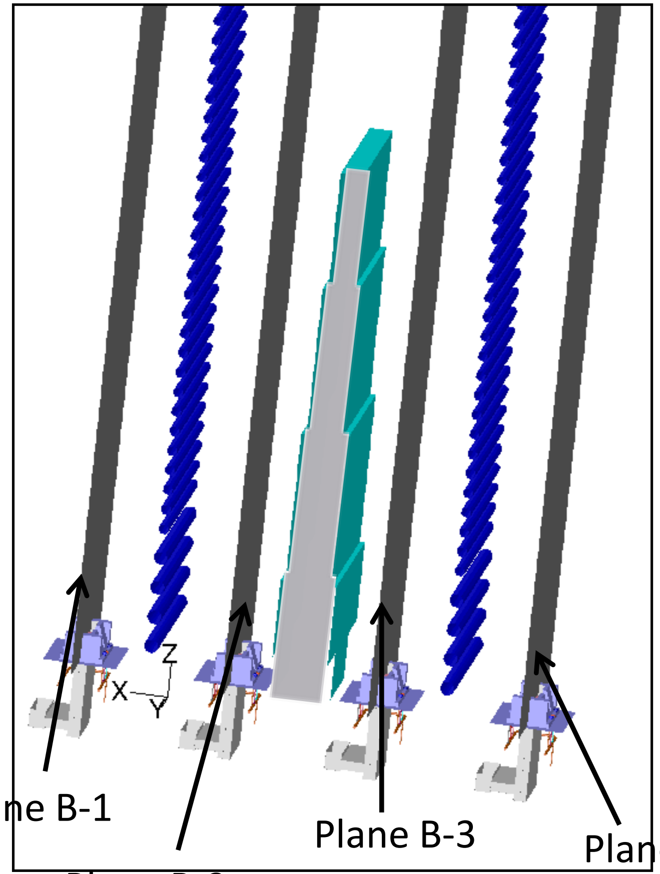


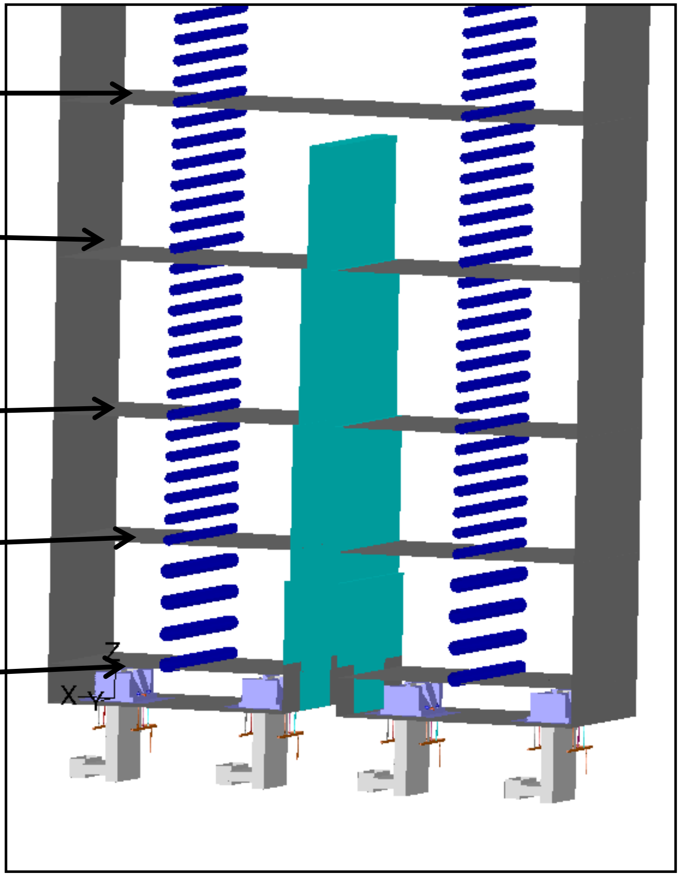
Burner Geometry

Planes Used for Results

❖ Planes along the center of burner

❖ Planes along the height of heater

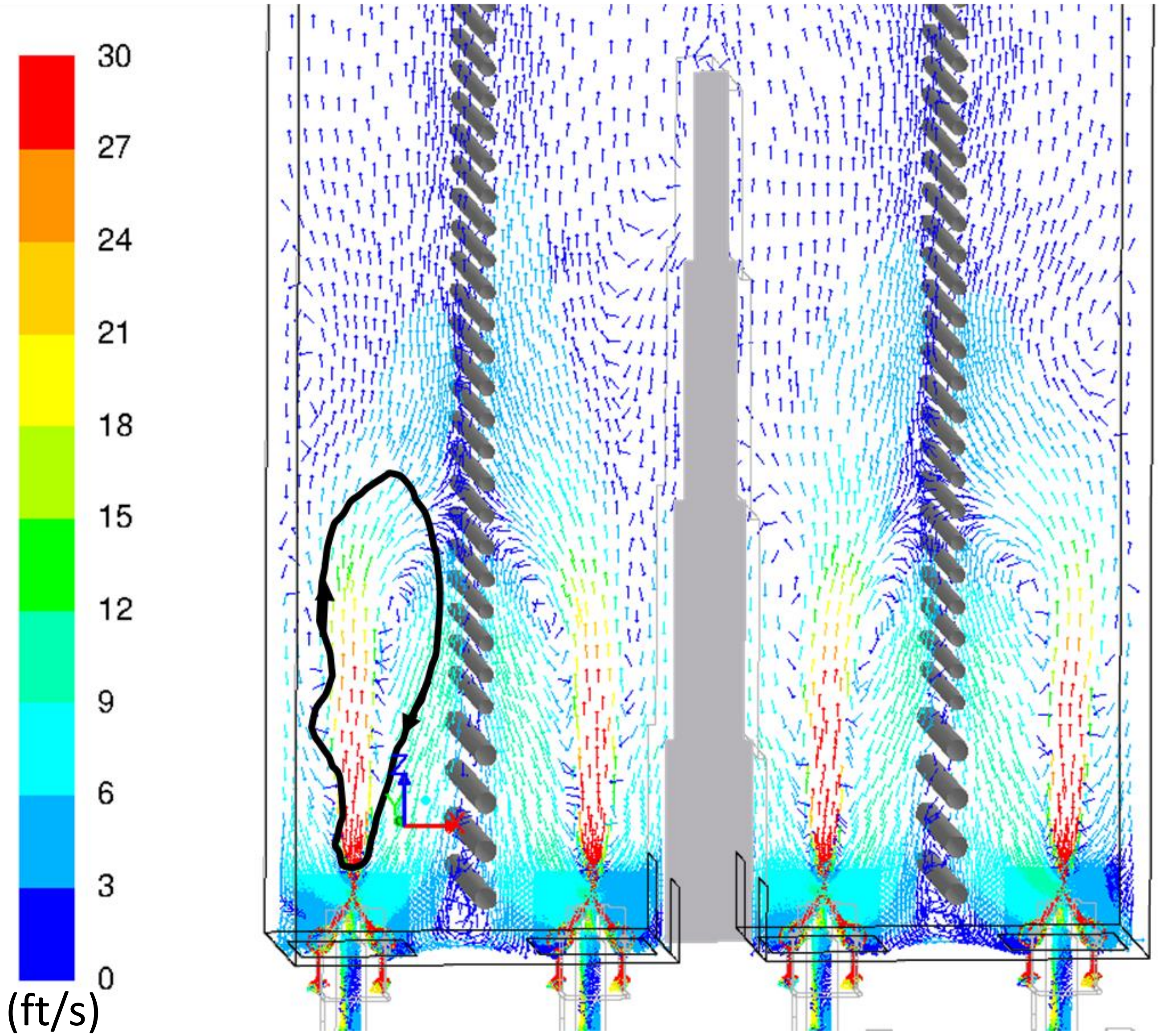




Results

- The flow pattern of flue gases is shown using
  - Velocity Vectors
  - Path Lines
- The temperature profile in the heater is shown using
  - Temperature Contours
- The flame profile is shown using
  - CO envelope of 2000 ppm

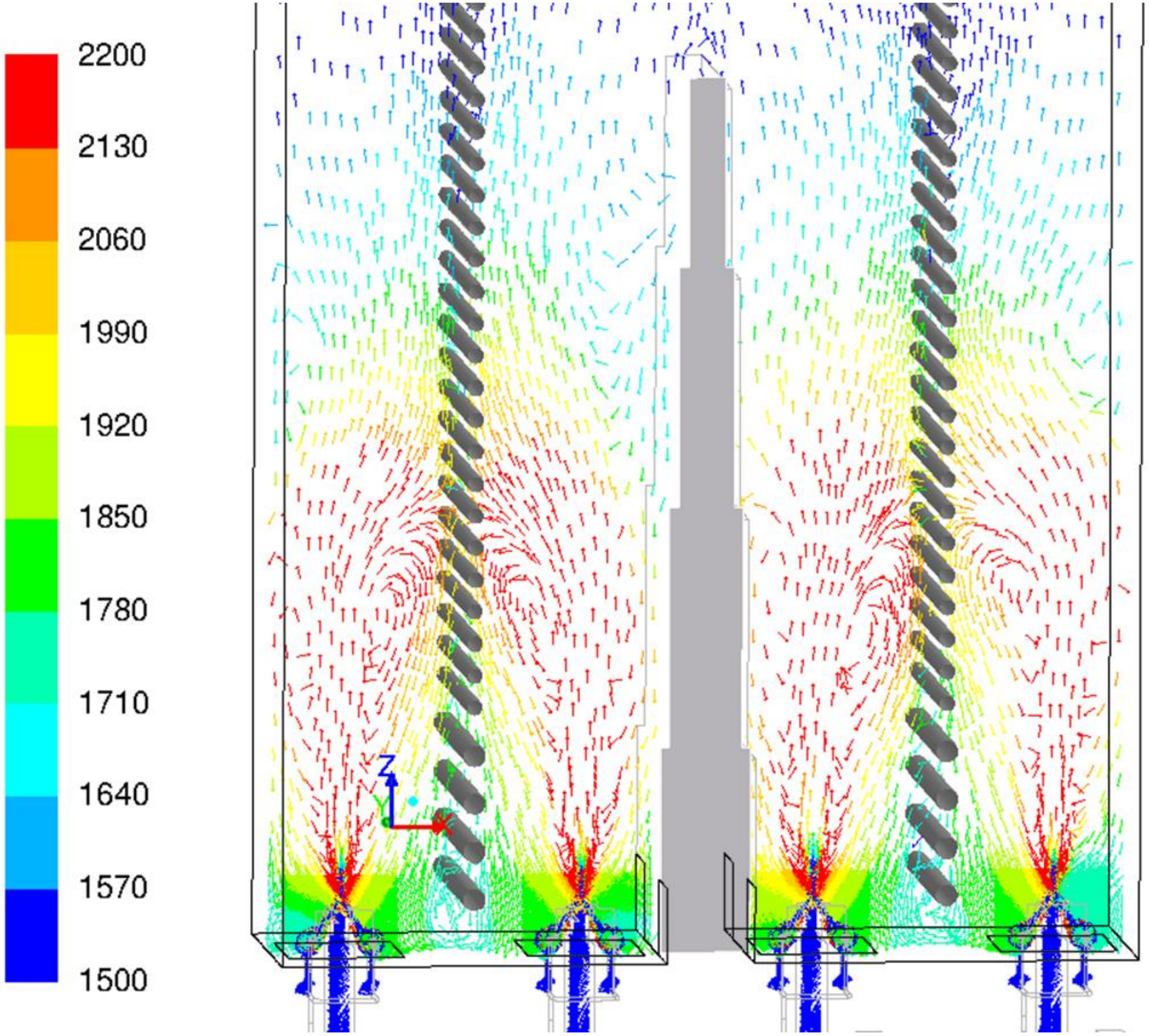
Velocity Vectors



Plane @ Primary tip

Vertical Firing

Velocity Vectors (by temperature)

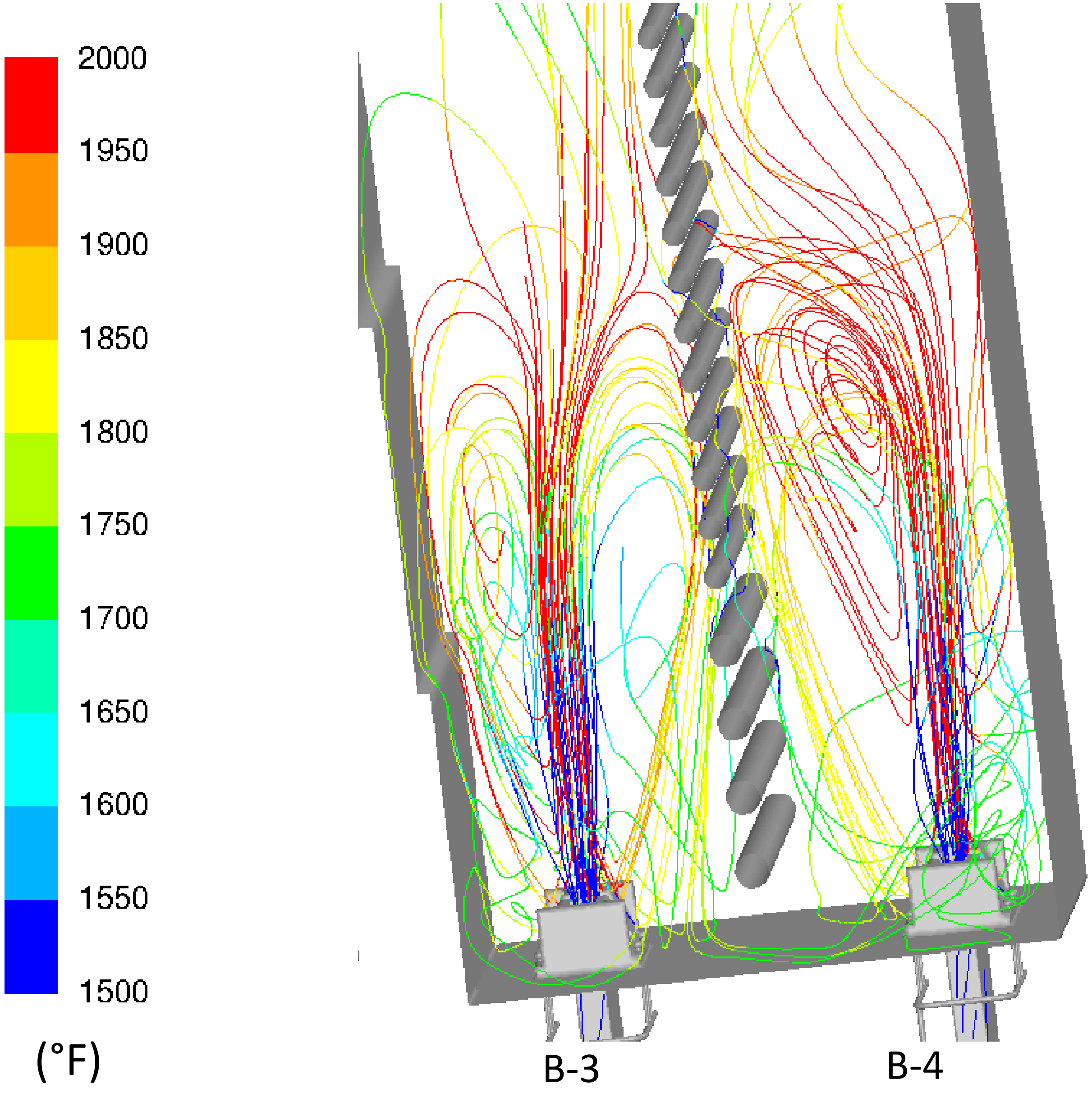


Vertical Firing

(°F)

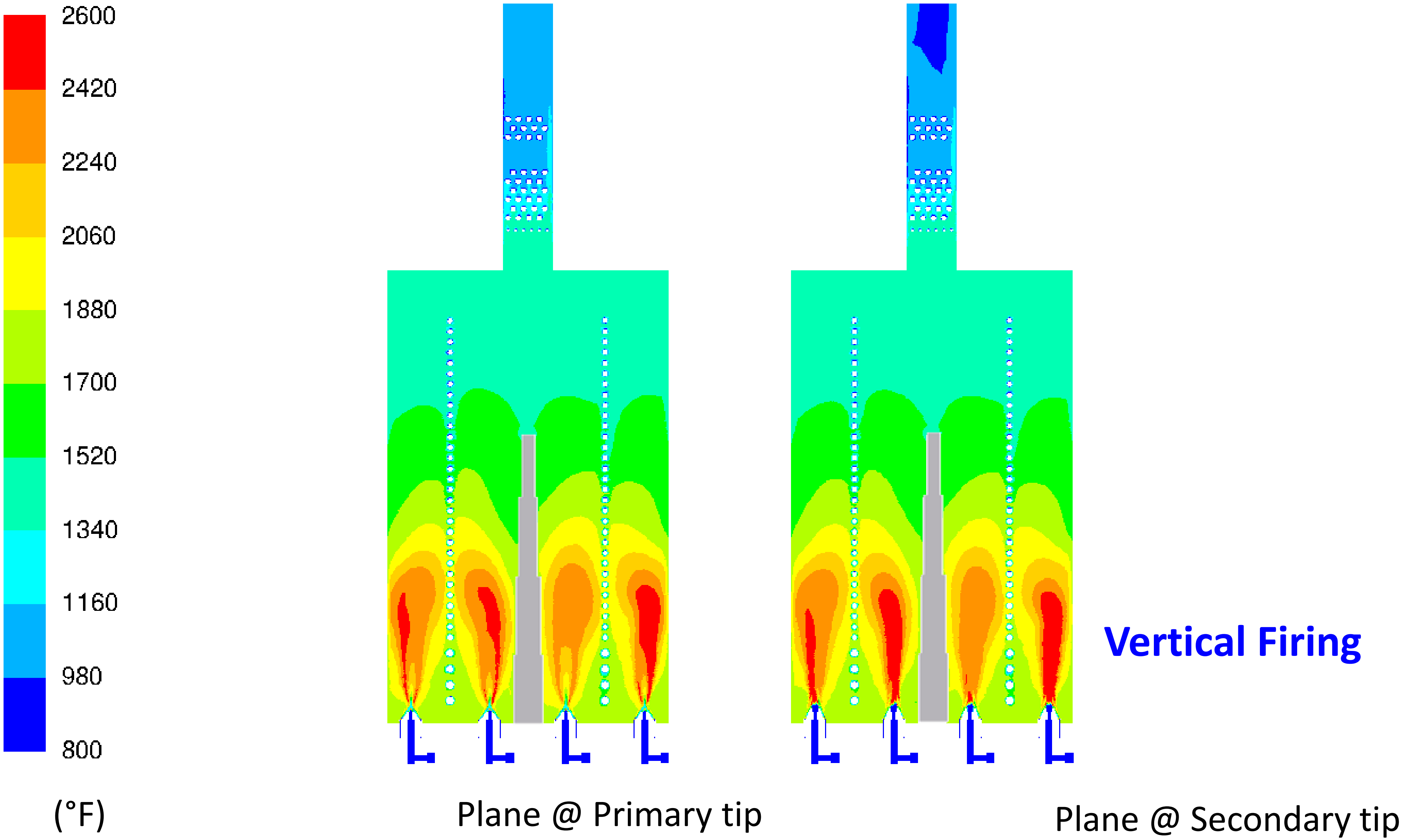
Plane @ Primary tip

Path Lines



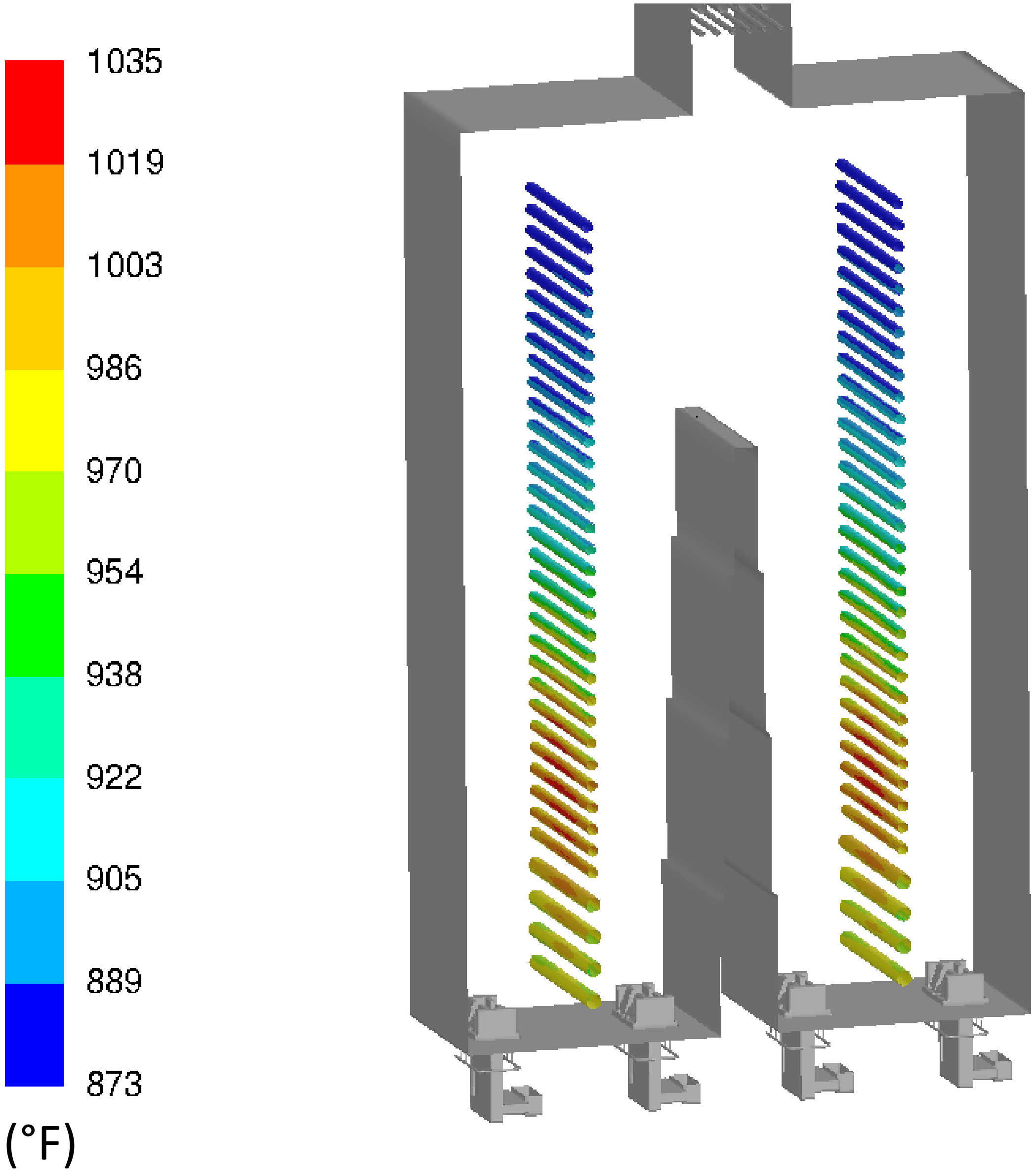
Vertical Firing

Temperature Contours



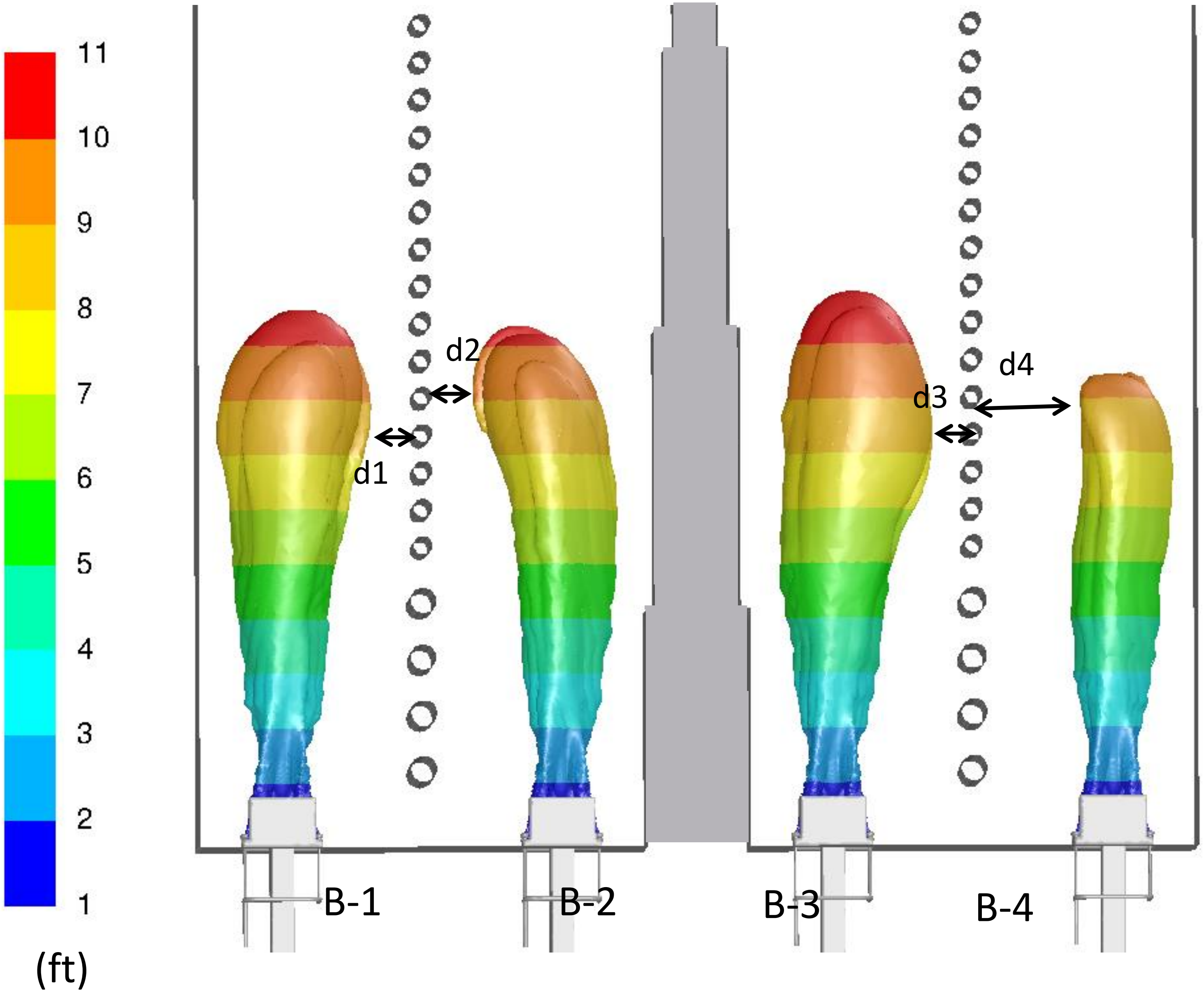
Vertical Firing

Tube Metal Temperature Contours



Vertical Firing

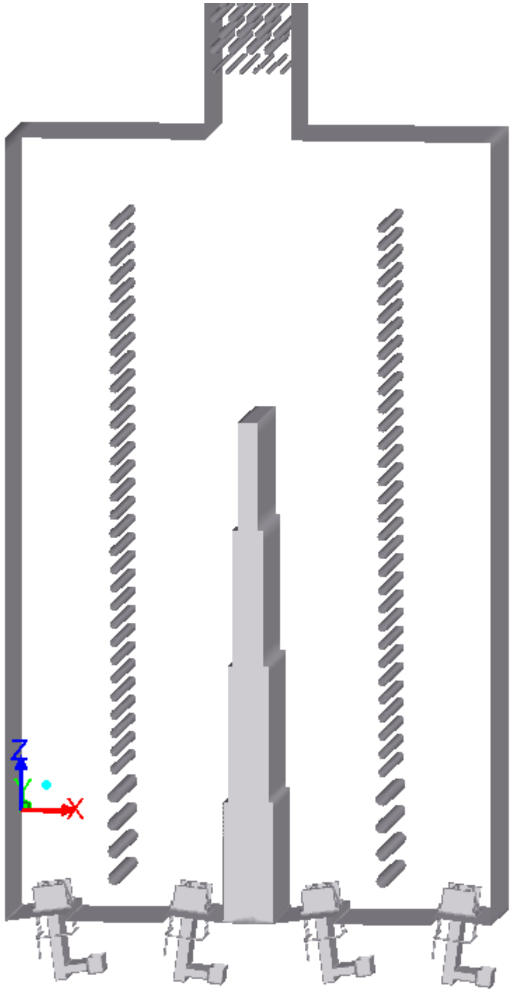
Iso-Surface of CO 2000 ppm



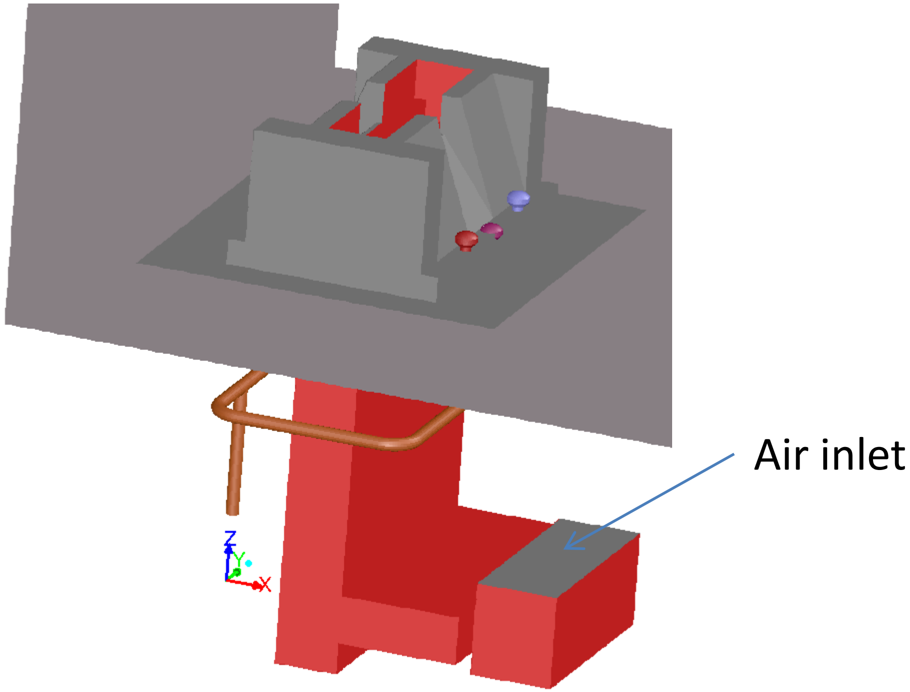
Minimum Distance From Tubes	Ft
d1	0.65
d2	0.71
d3	0.44
d4	1.5

Vertical Firing

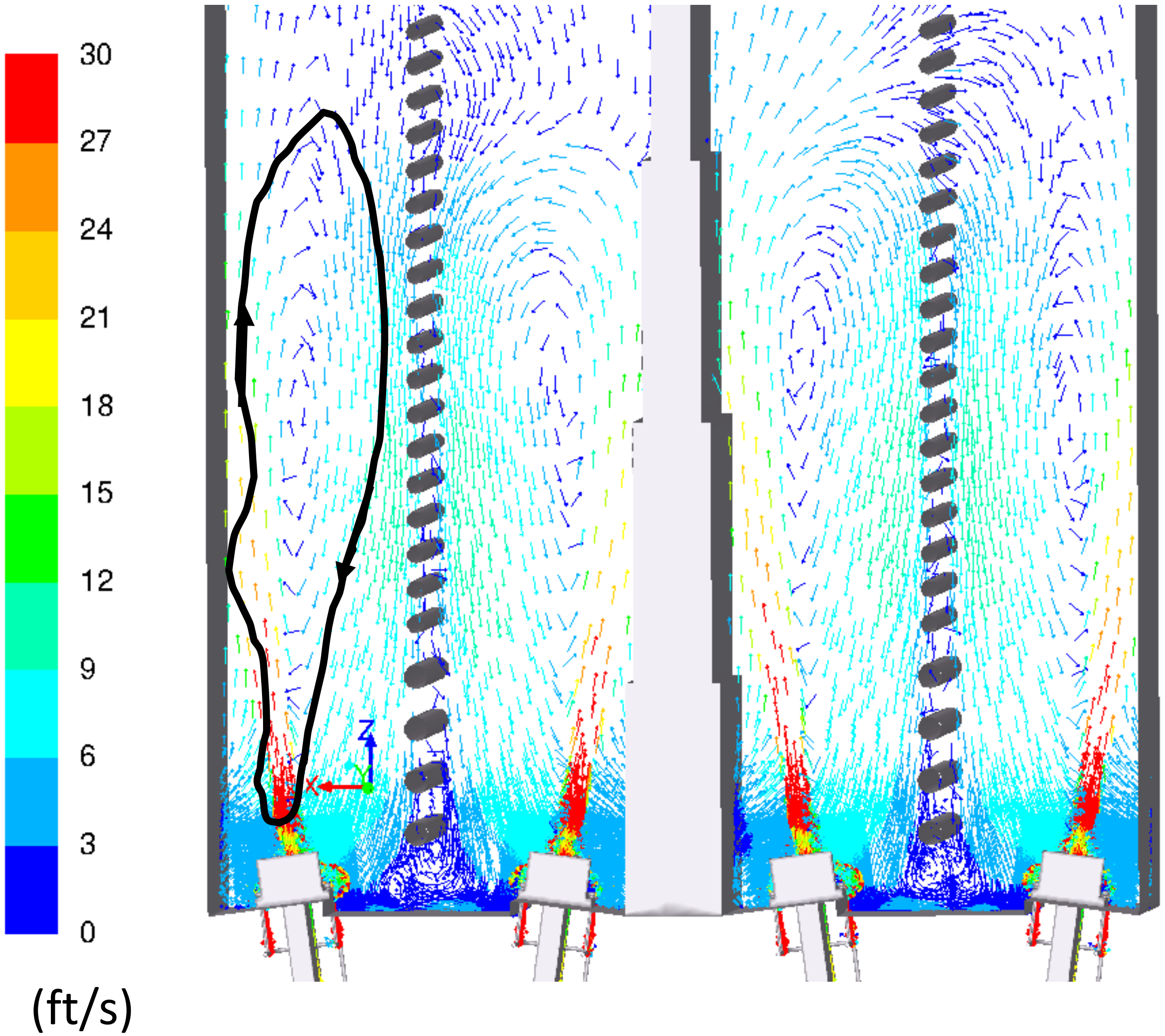
Inclined Firing



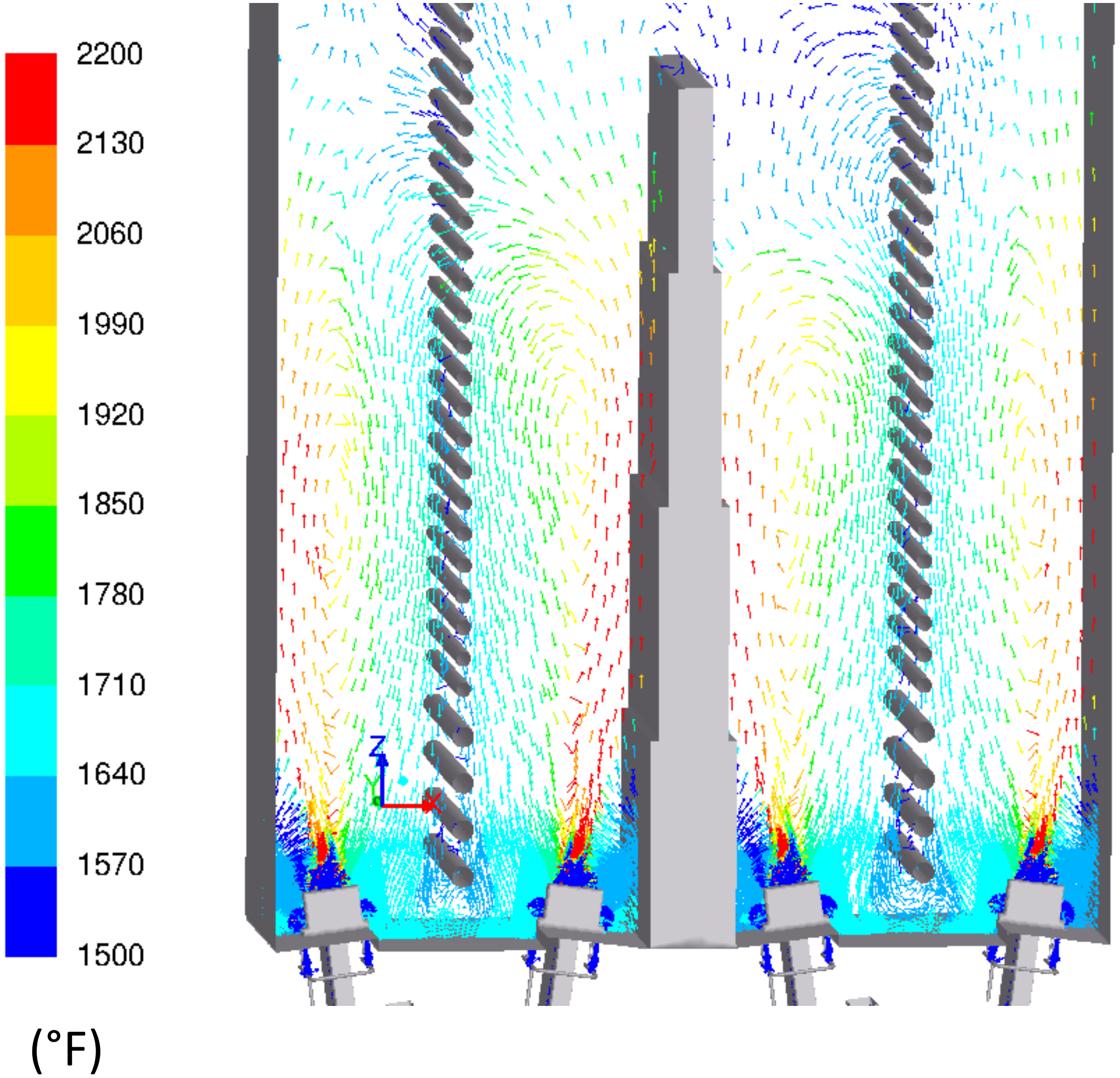
Burners are inclined by 7.5 deg towards the walls



Velocity Vectors

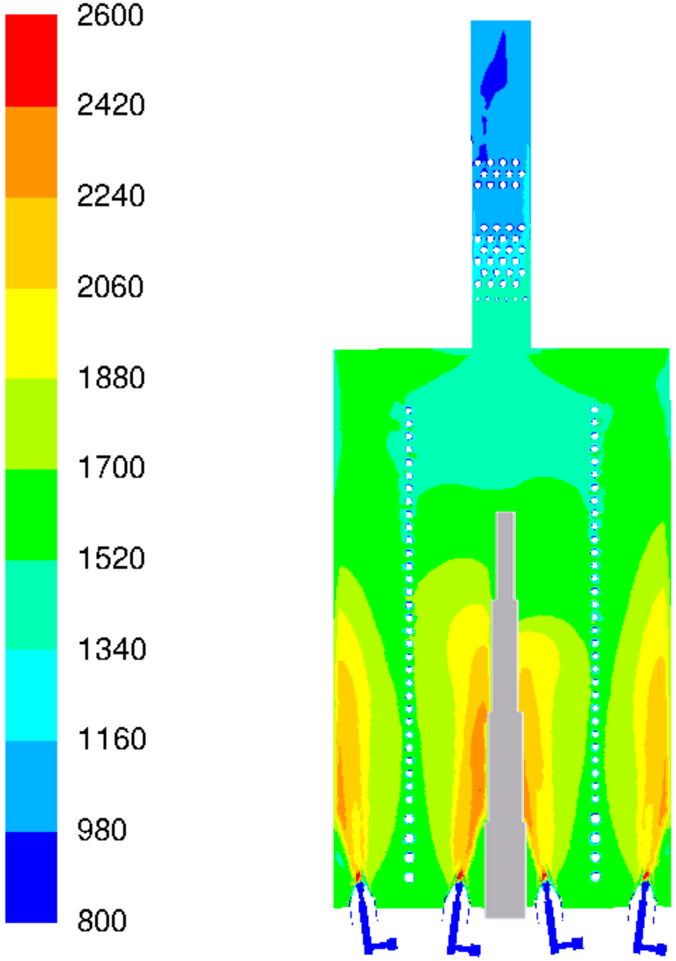


Colored by Velocity



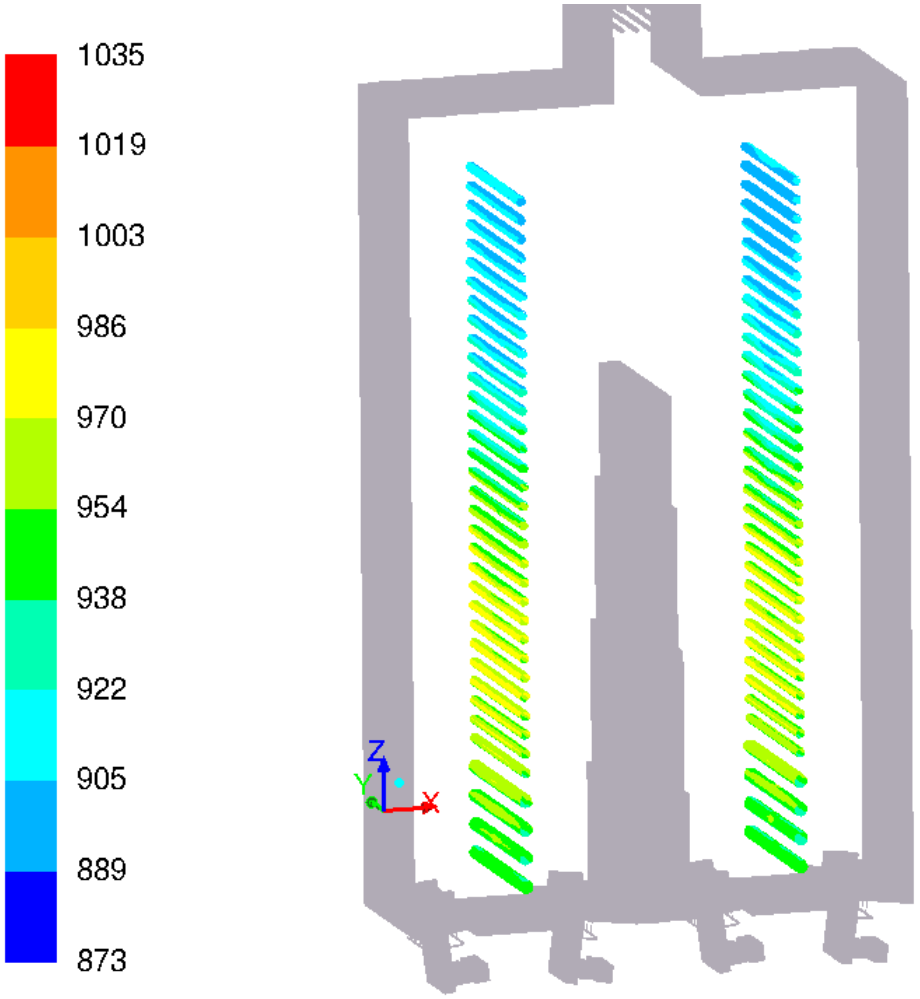
Colored by Temperature

Temperature Contours



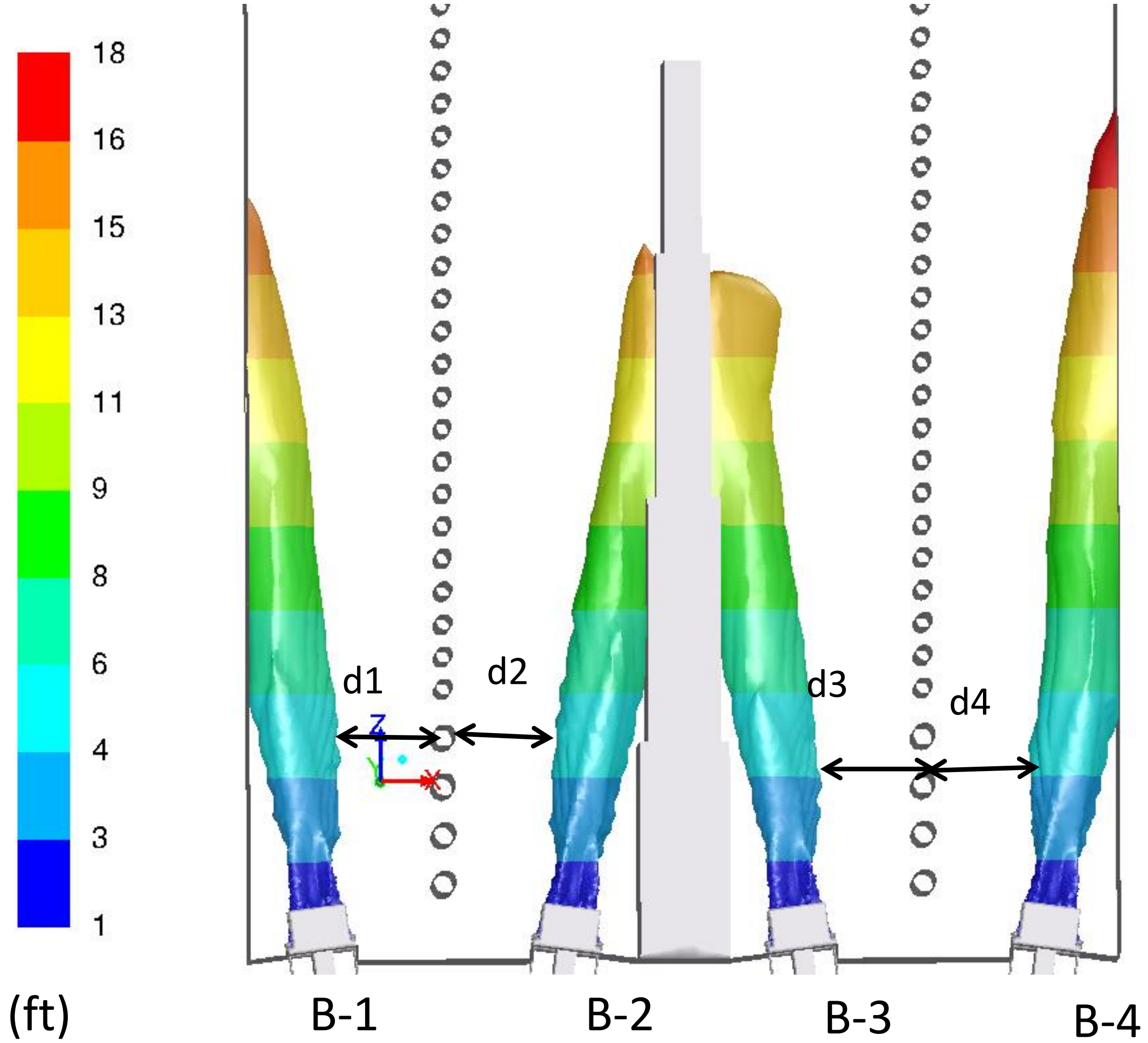
(°F)

Plane @ Primary tip



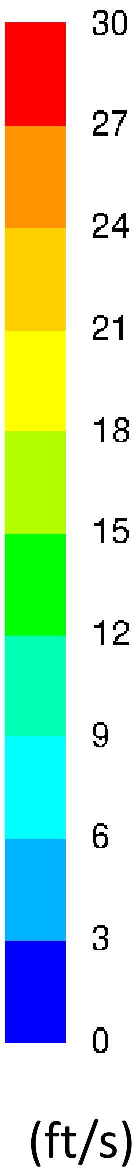
(°F)

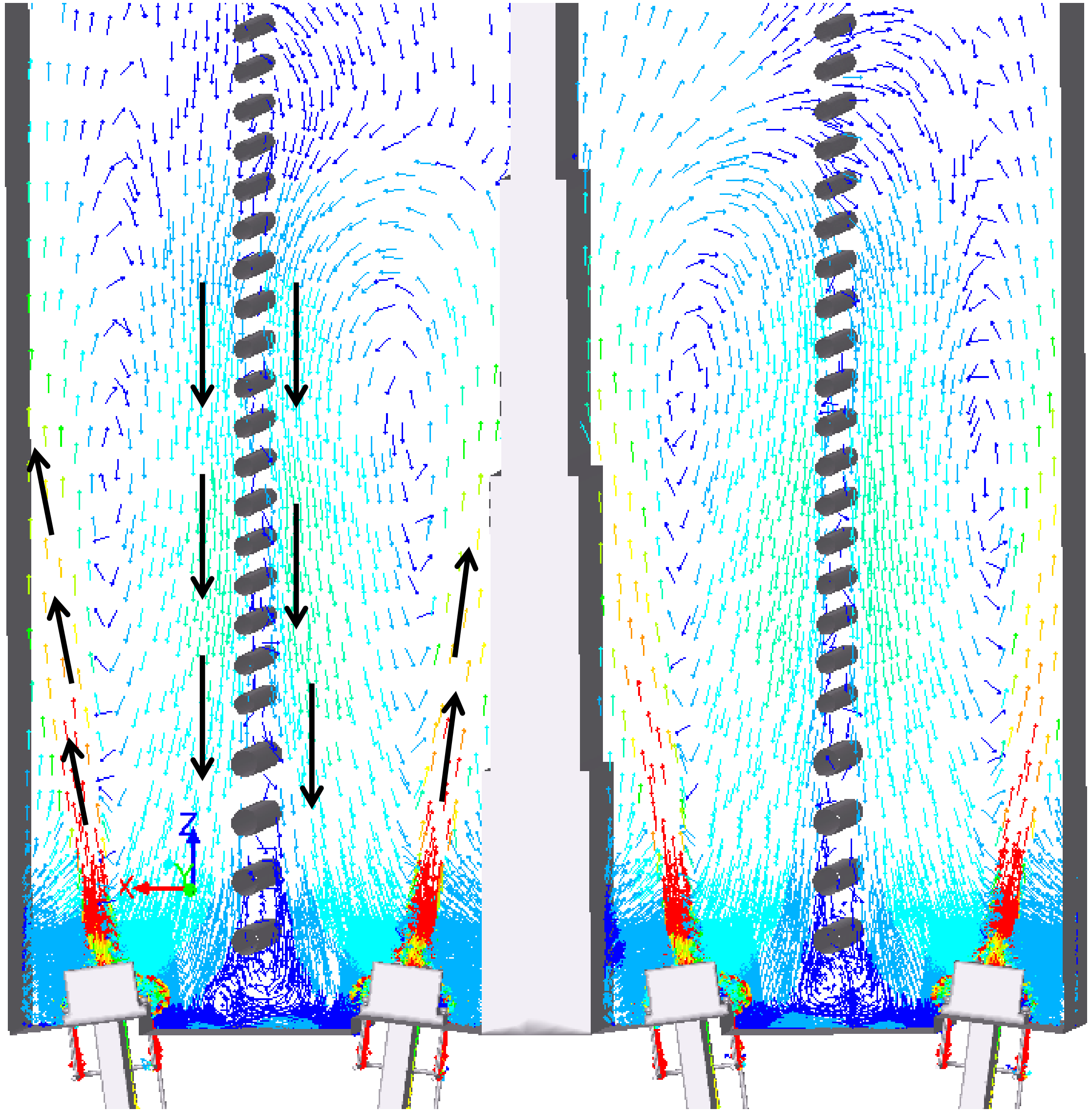
Iso-Surface of CO 2000 ppm



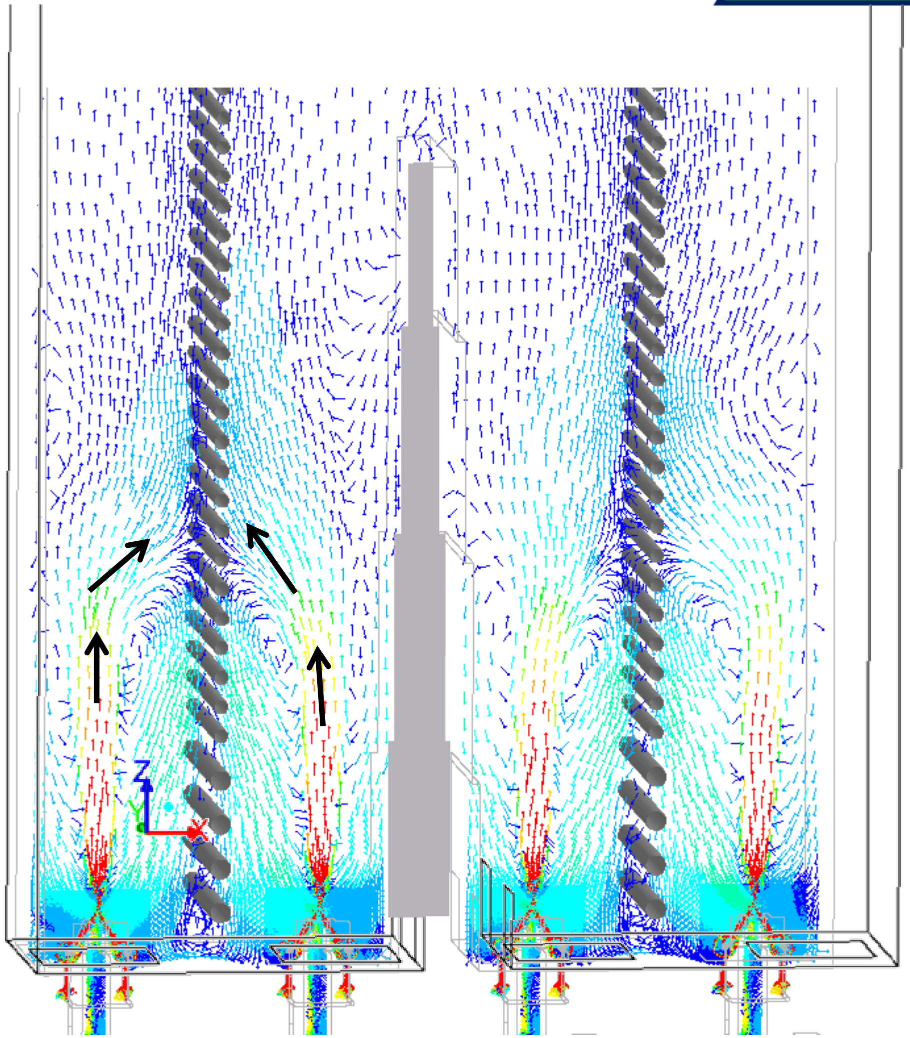
Minimum Distance from tubes	ft
d1	2.1
d2	2.2
d3	2
d4	1.9

Vertical vs. Inclined Firing



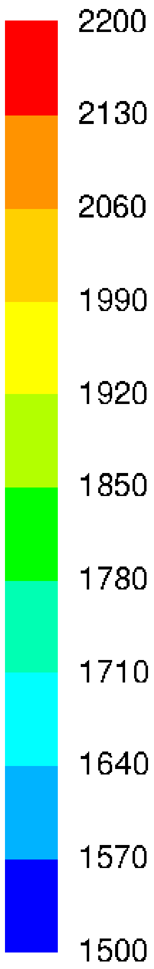


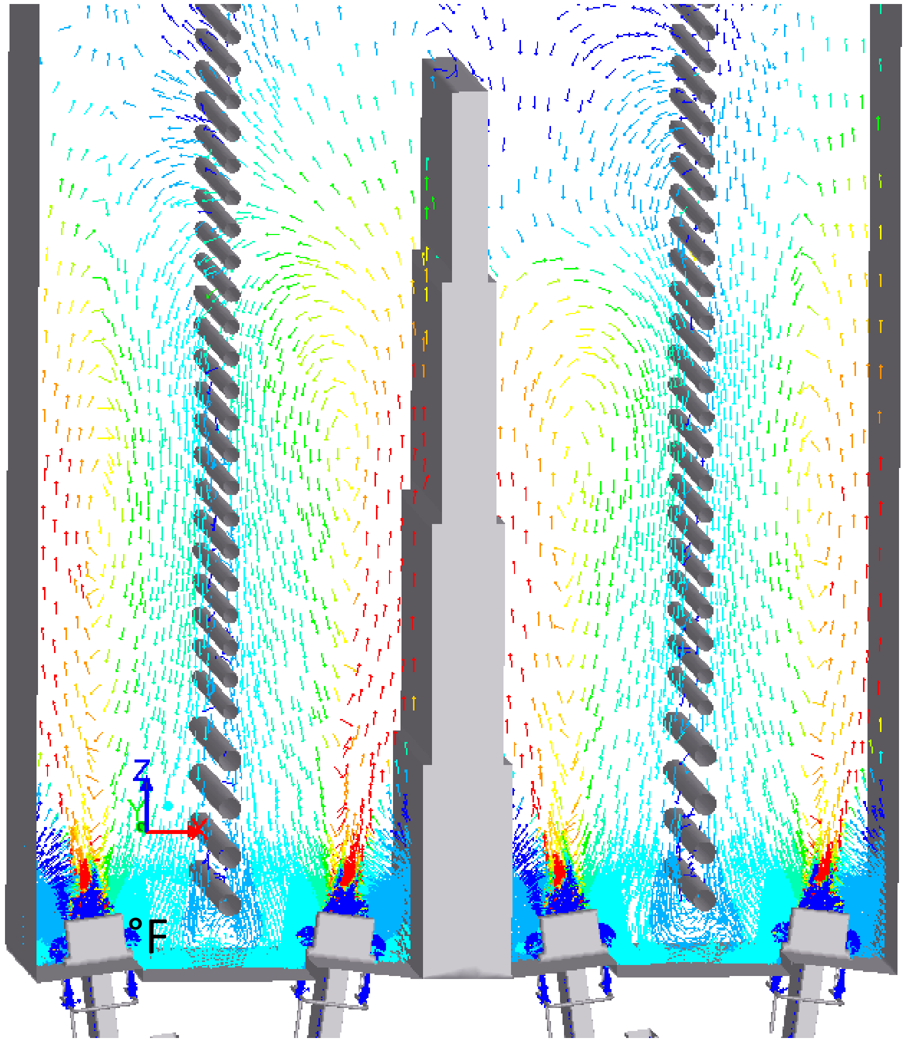
Inclined Firing



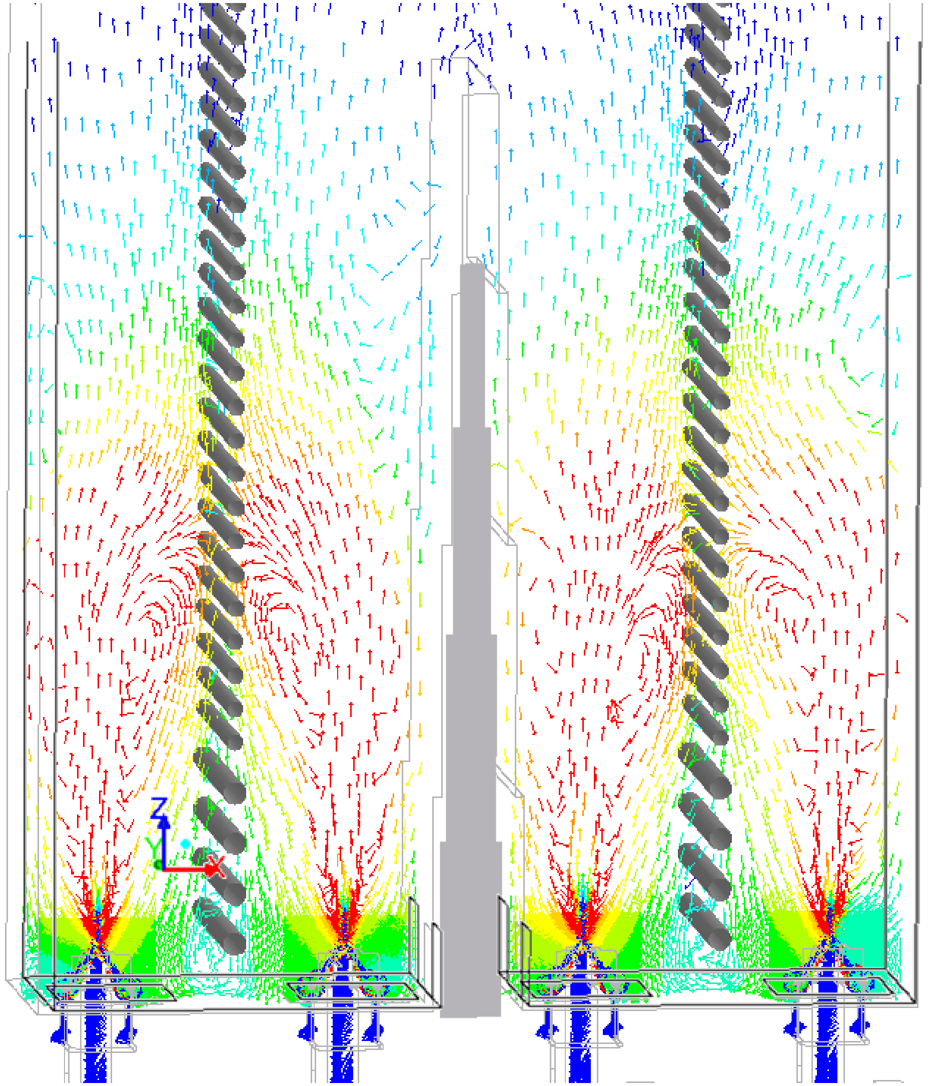
Vertical Firing

Vertical Up Firing vs. Inclined Firing





Inclined Firing



Vertical Firing

Comments

- ❖Inclining the burners towards the radiant and fire brick gravity wall helps to direct the flames away from radiant tubes
- ❖Flue gas temperature around radiant tubes is reduced
- ❖Inclined firing in addition to the proposed modifications for radiant coils will enhance the performance of the heater

Thank You Very Much

- We hope you will find our presentation helpful and informative.