REFCOMM
GALVESTON
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Improving Shale Oil Crude Heater Performance

Furnace Improvements

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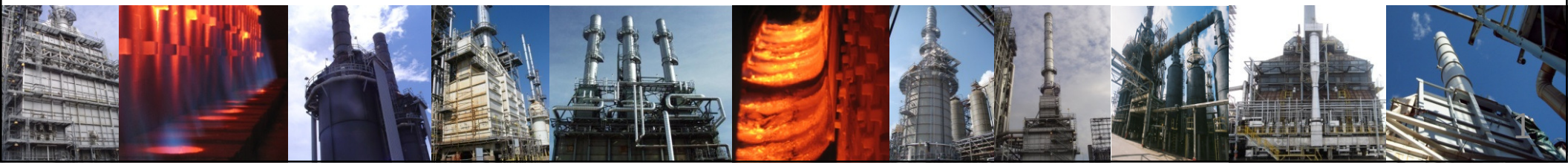
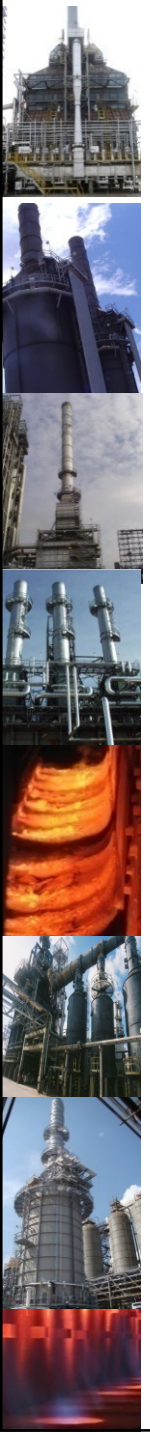
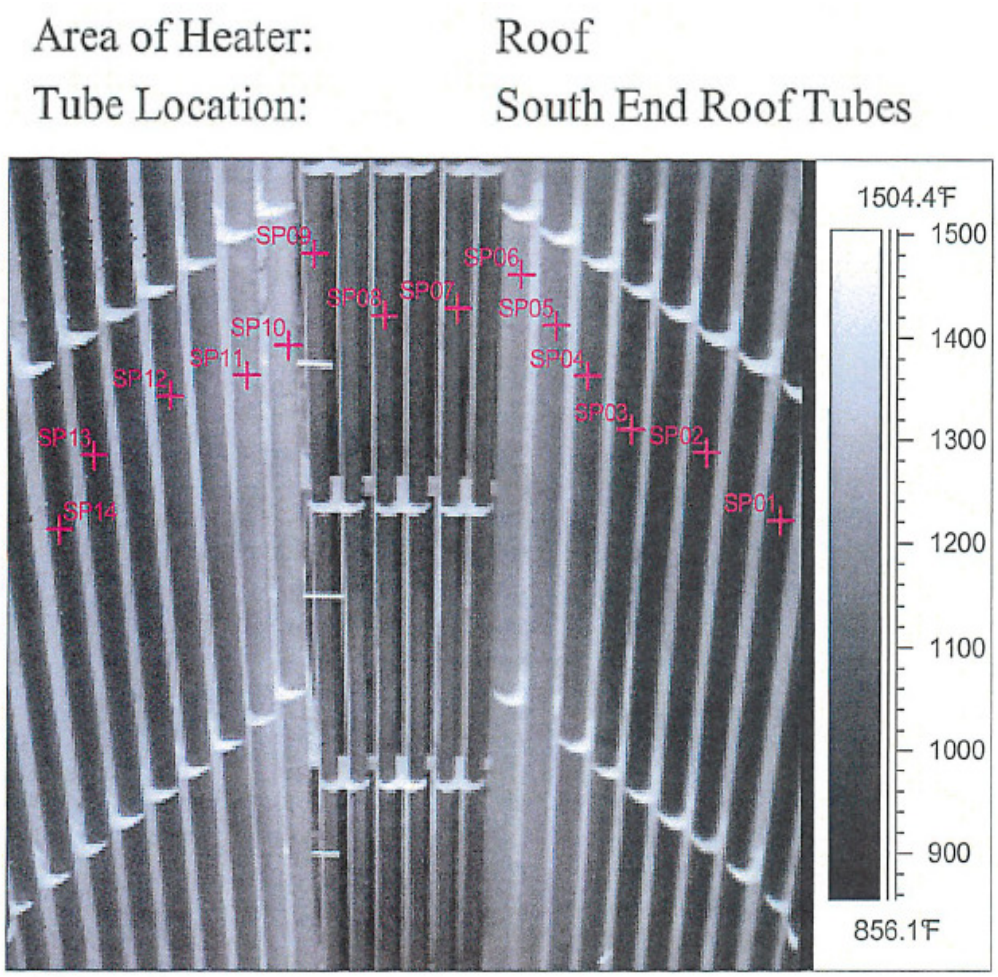


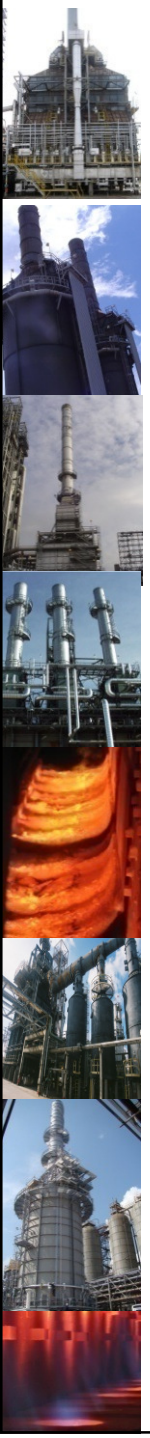
Objective



- Reduce coking rate in the Crude Heater
- Reduce tube metal temperatures in tubes near arch
- Uniform heat distribution in the heater

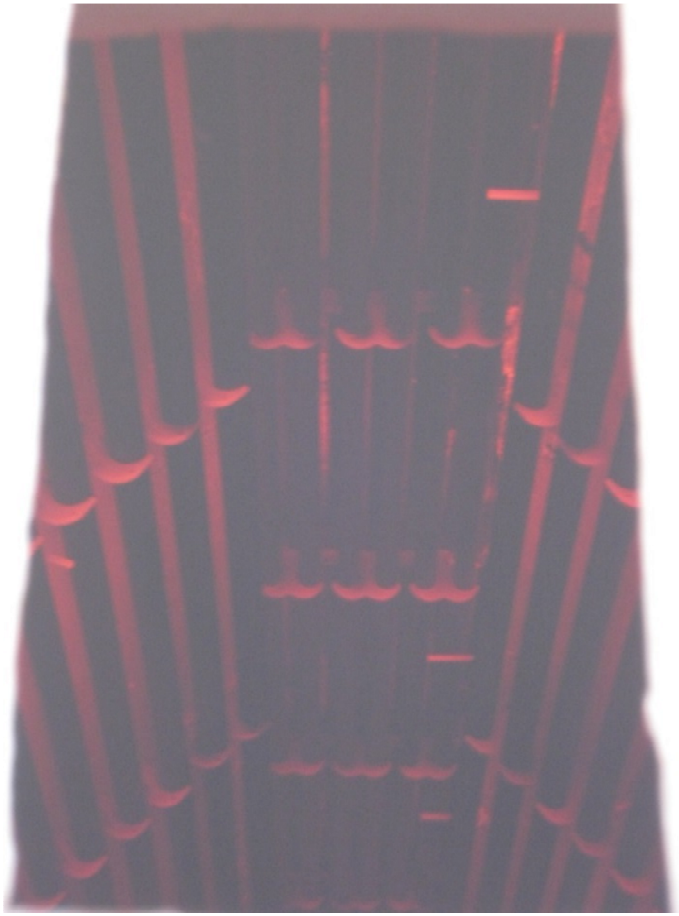


Crude Heater

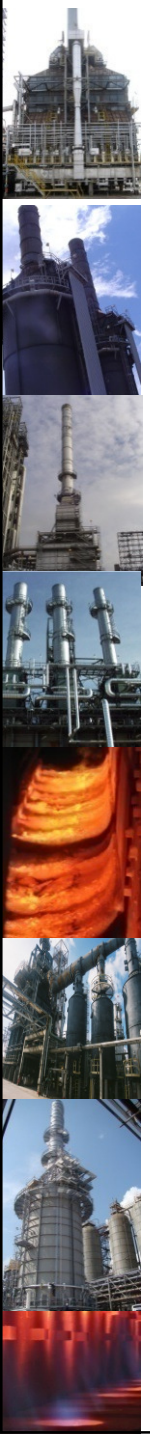


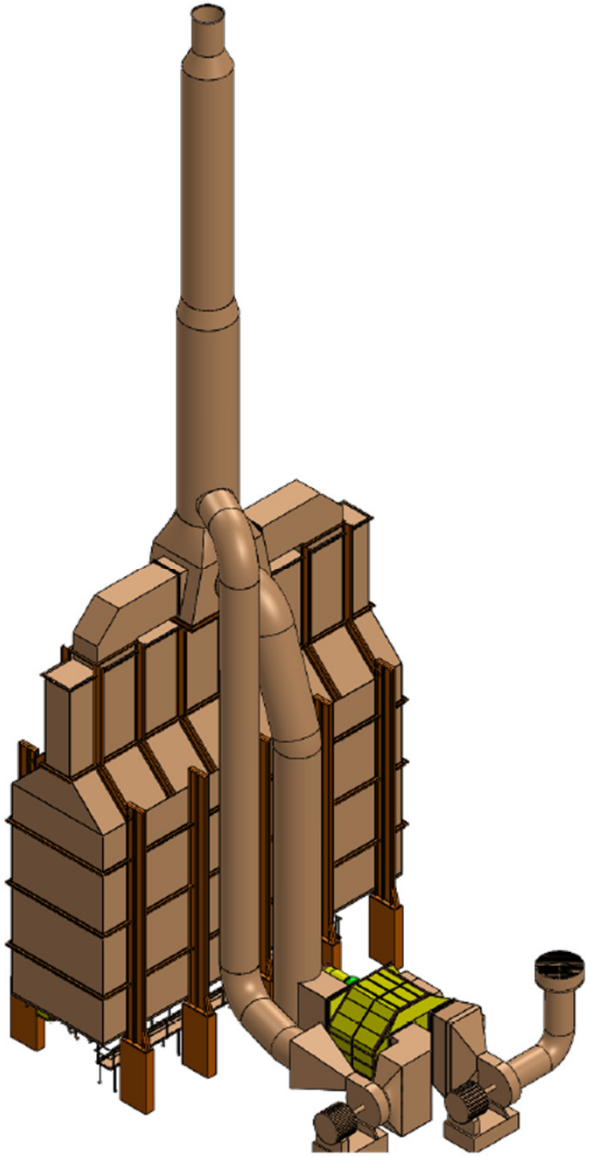
Cabin Type Heater

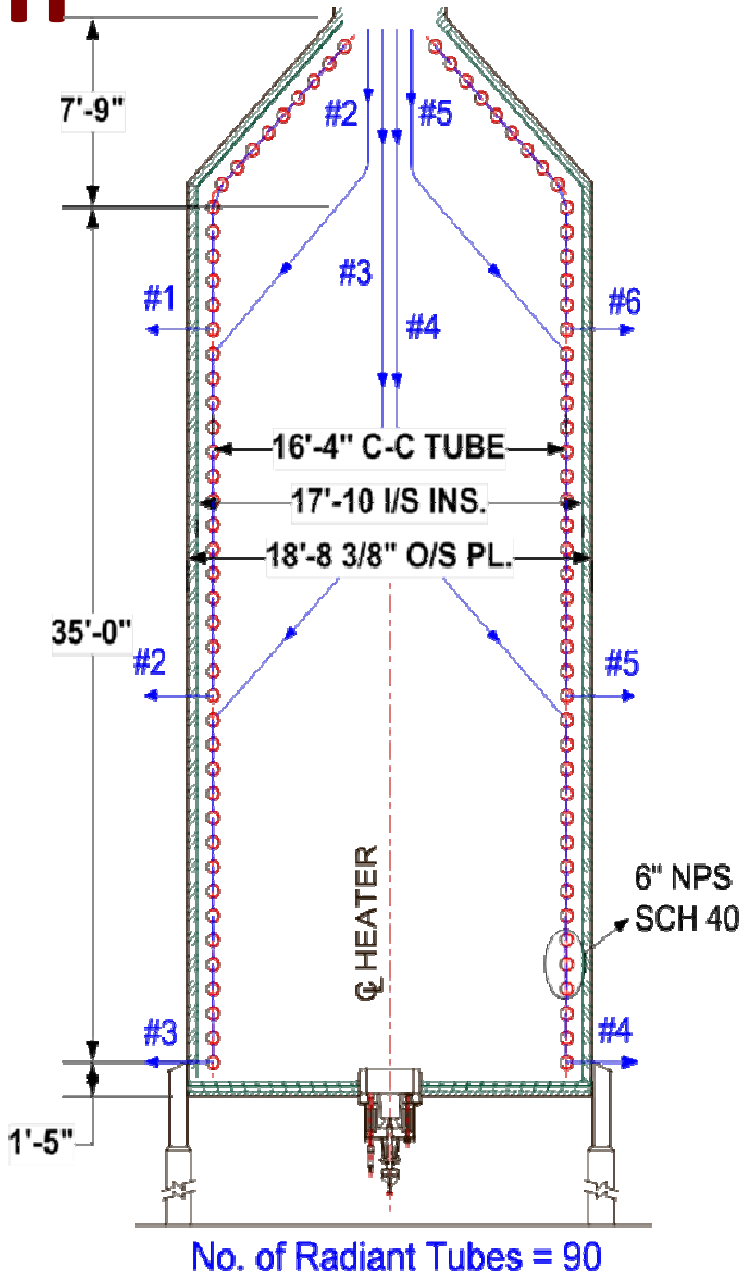
- Horizontal Tube Radiant & Convection Section
- Gas Fired Low NOx Burners
- Heater Duty = 155.7 MM Btu/hr
- Charge Flow rate = 50,376 BPD
- Temperature (Inlet/Outlet) = 427 / 720 °F
- Pressure (Inlet/Outlet) = 95 / 35 psig
- Avg. Flux Density = 12,000 Btu/hr-ft2



Existing Heater and Radiant Section



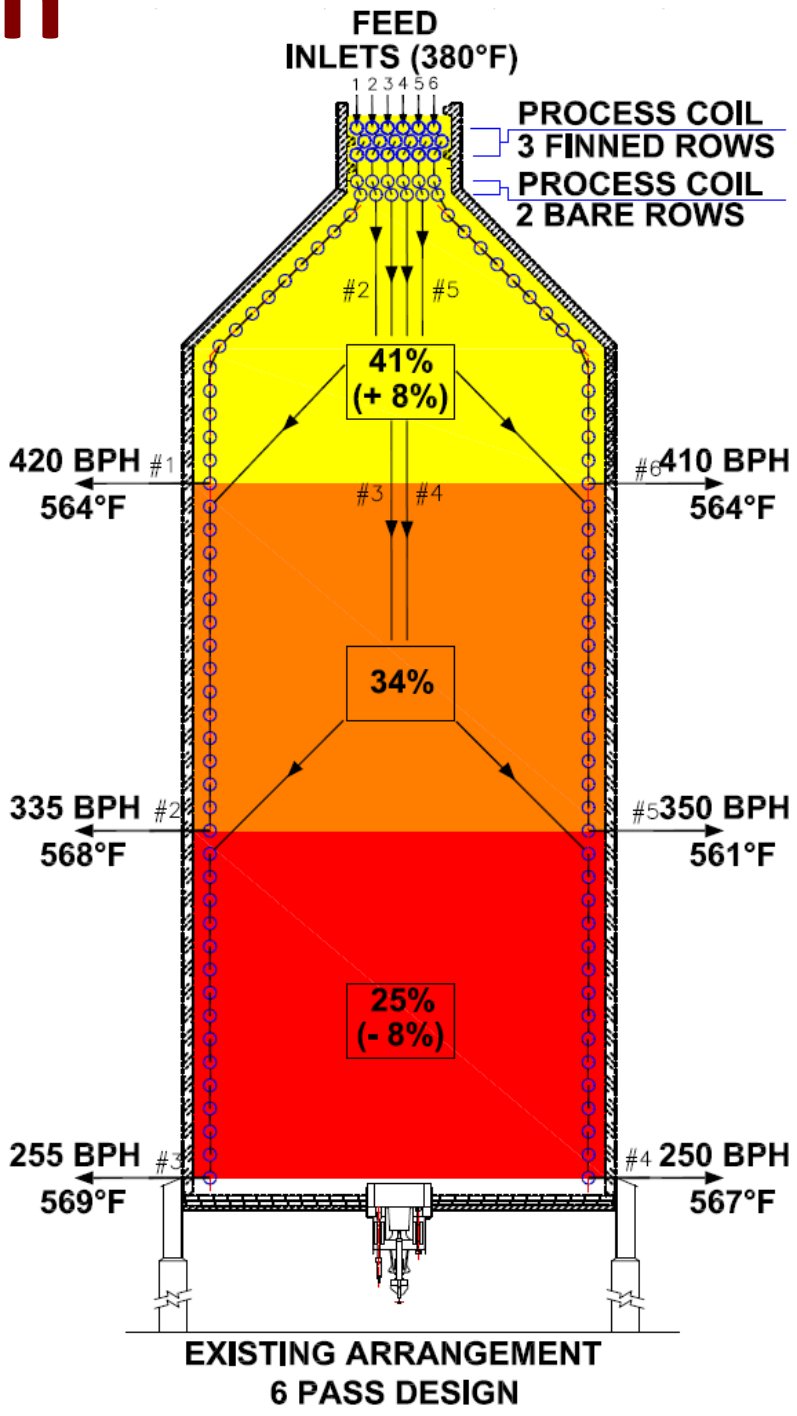




No. of Radiant Tubes = 90

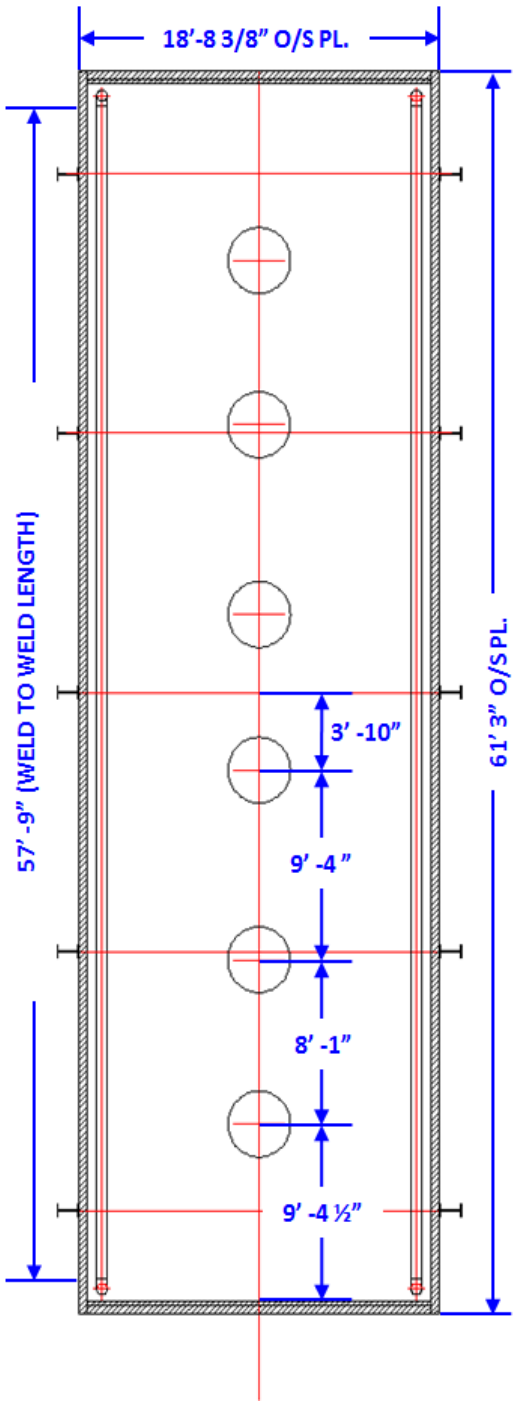
Heat Distribution Pattern

- Top portion is receiving maximum heat
- Heat distribution is not uniform
- Pass imbalance

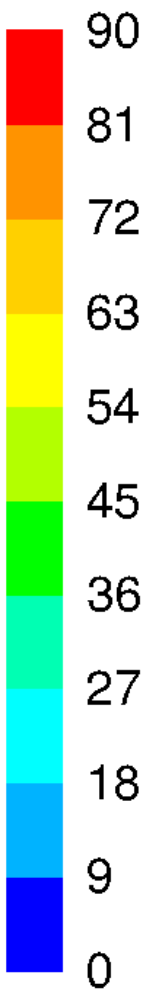


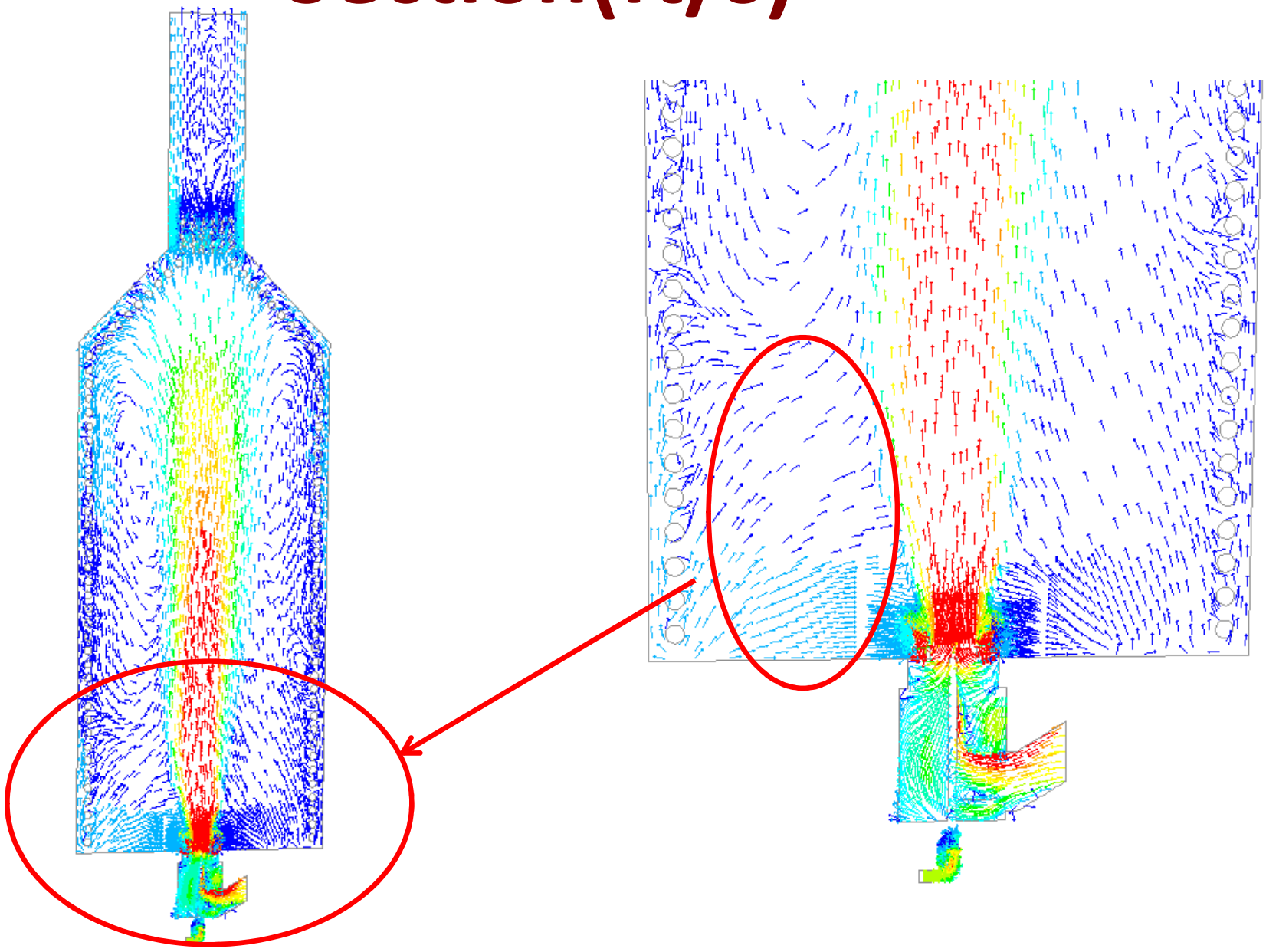
Existing Burners

Parameter	Unit	Value
Numbers	Nos.	6
Maximum Heat Release per Burner	MMBtu/hr	38.9
Turndown Ratio	-	4:1
Location	-	Floor Mounted
Draft Loss Across Burners (at max. firing)	in W.C	3.87

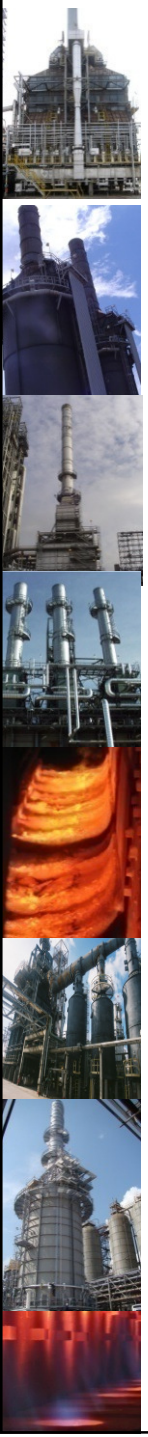


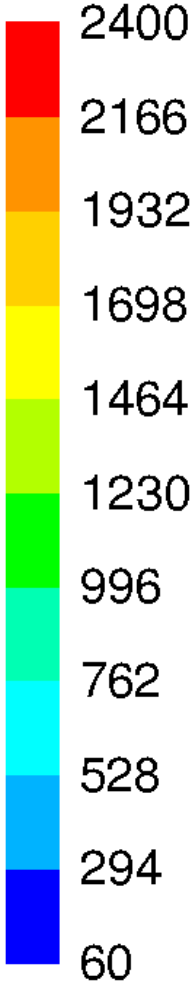
Velocity Vectors at Z-1 Section(ft/s)

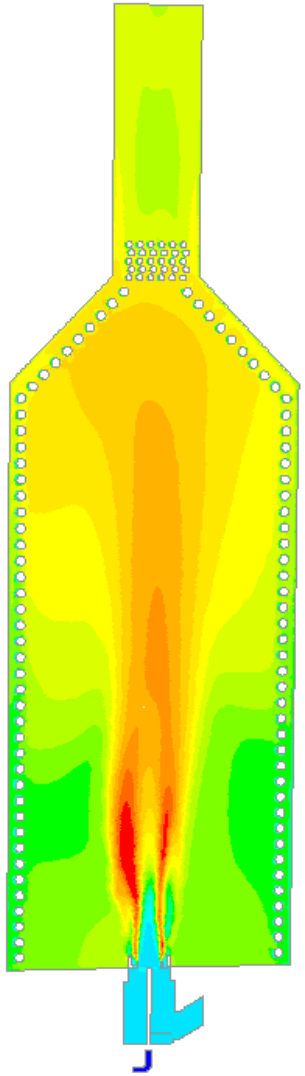


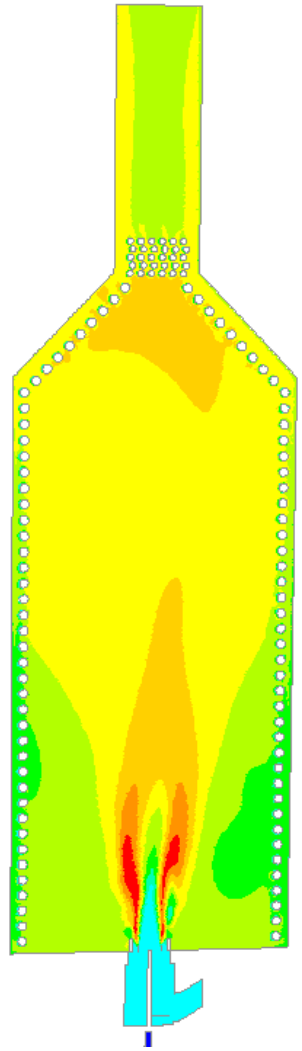


Temperature Contours at Z Section(deg F)

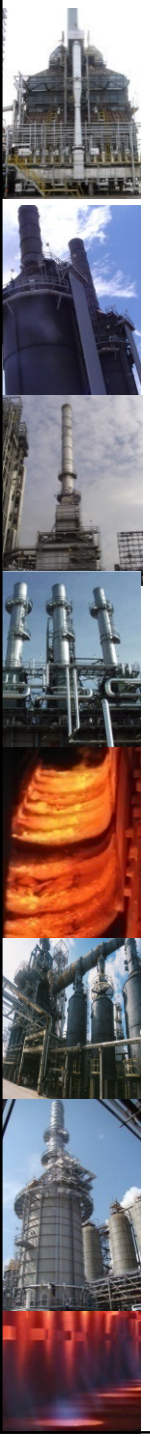


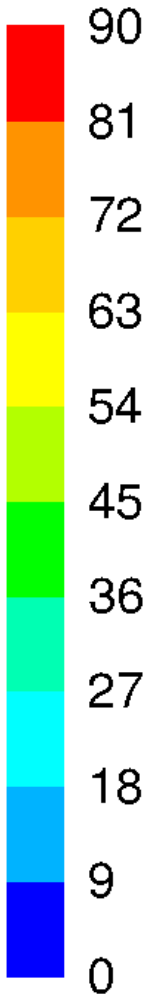


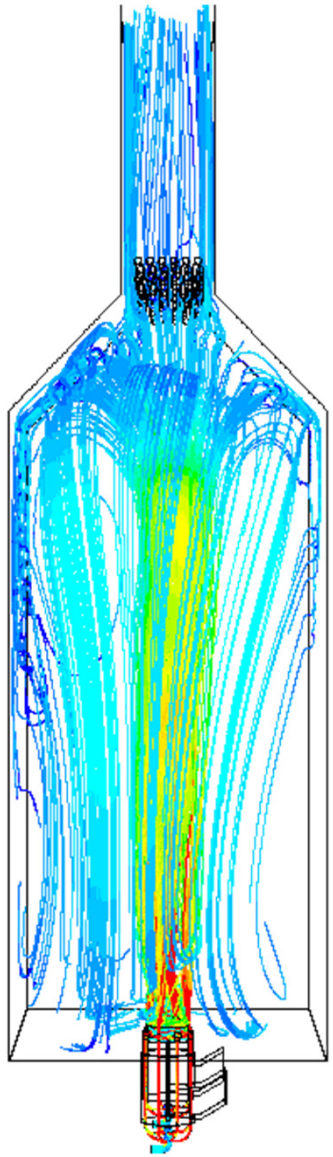




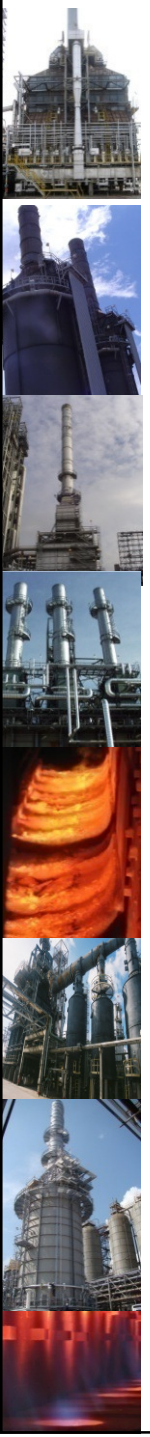
Pathlines colored by velocity (ft/s)

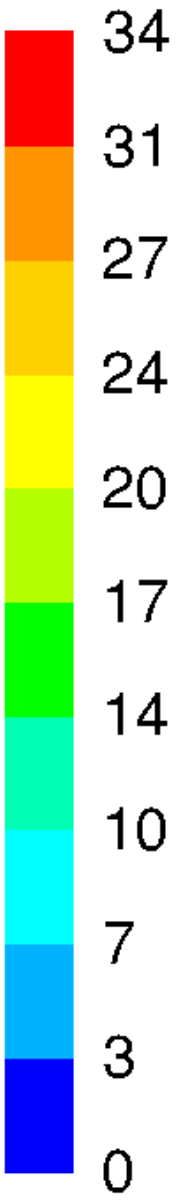


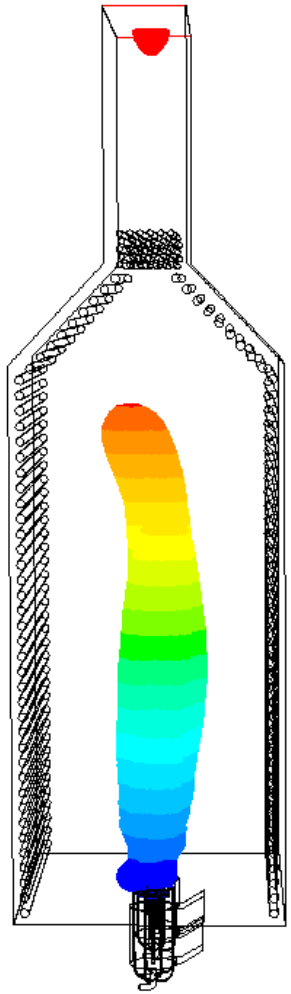


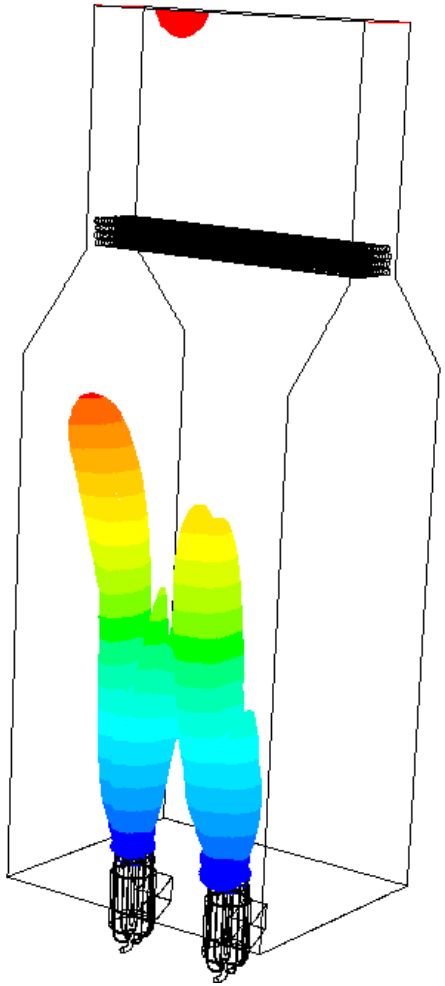


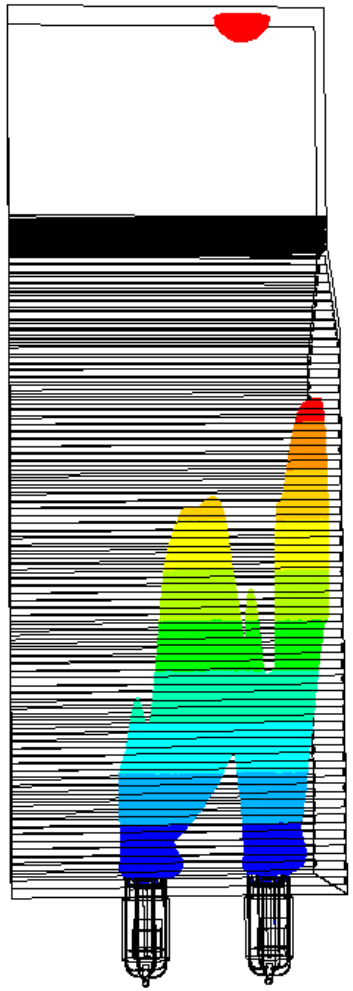
Flame Colored by Height (ft)



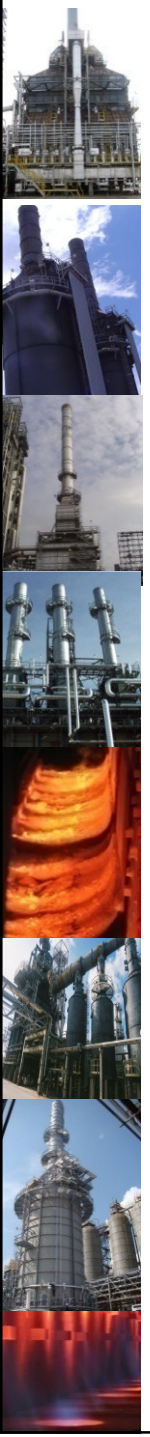


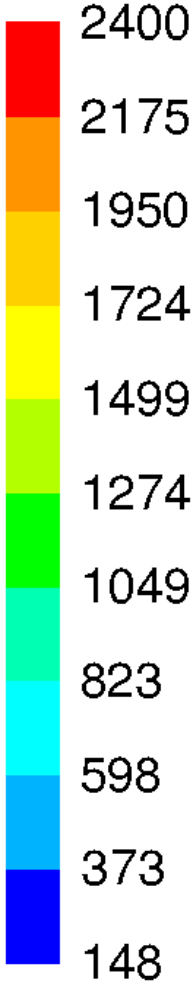


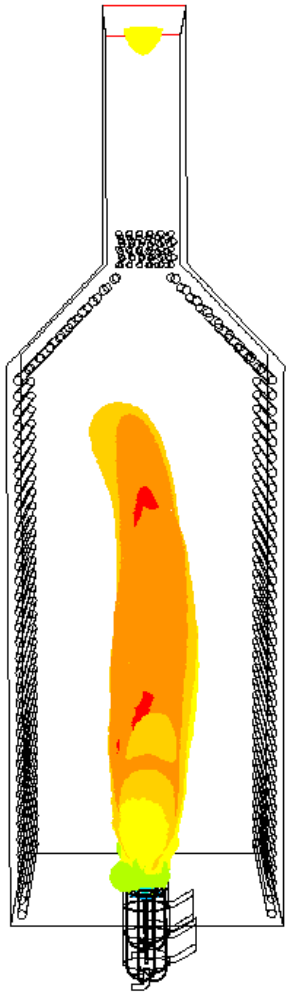


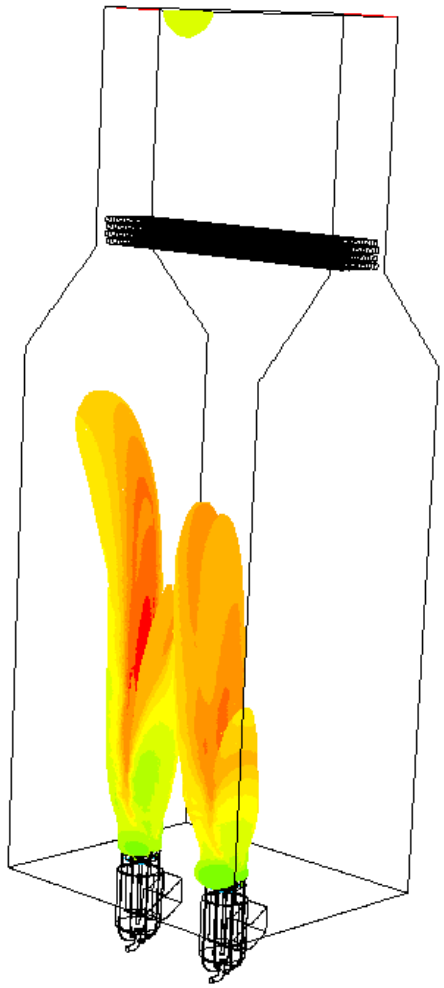


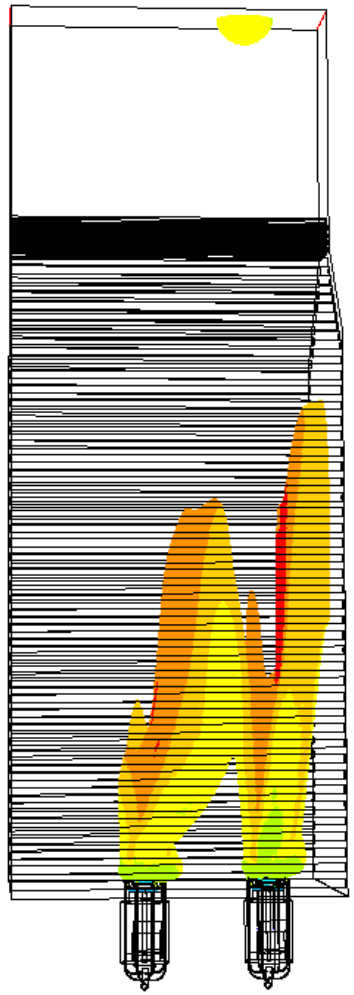
Flame colored by Temperatures (deg F)



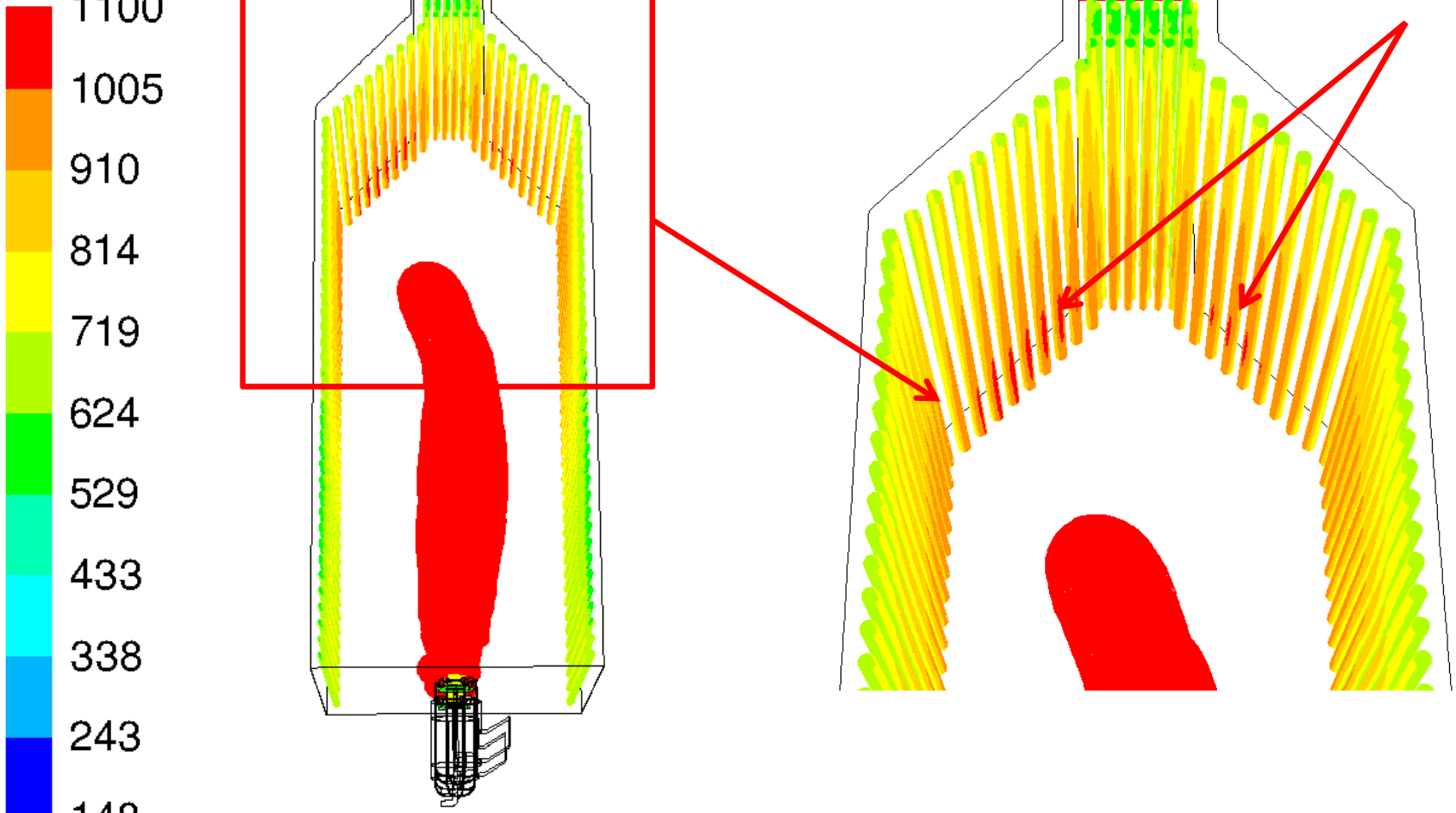




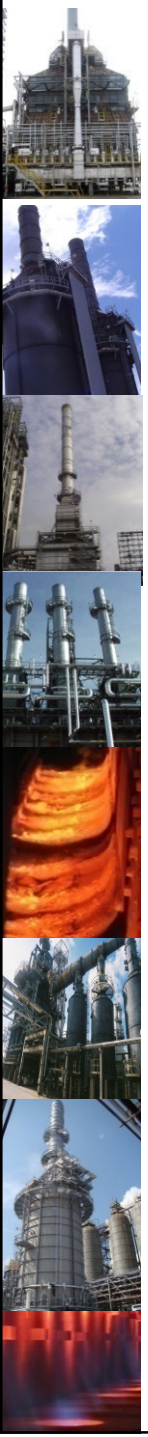


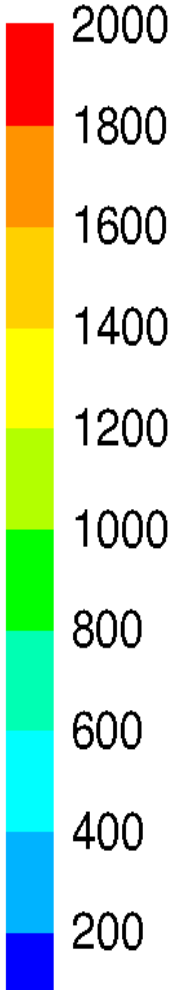


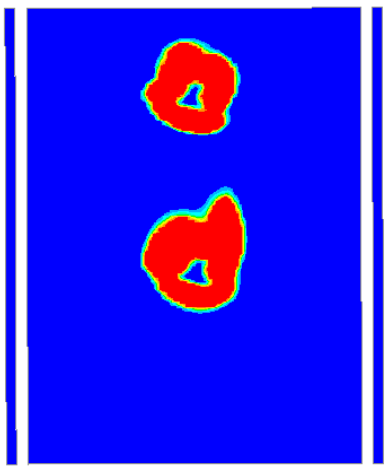
Radiant Tubes Temperature Contours (deg F)

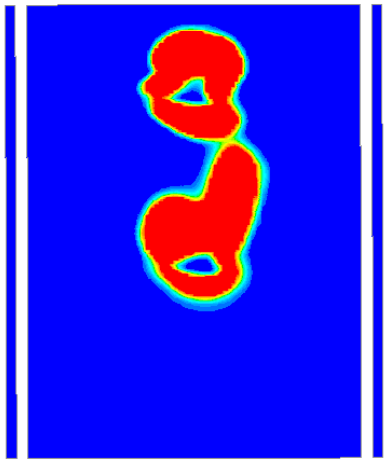


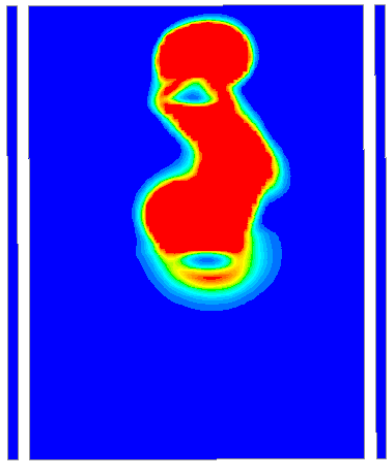
CO Contours at Different Elevations of Heater

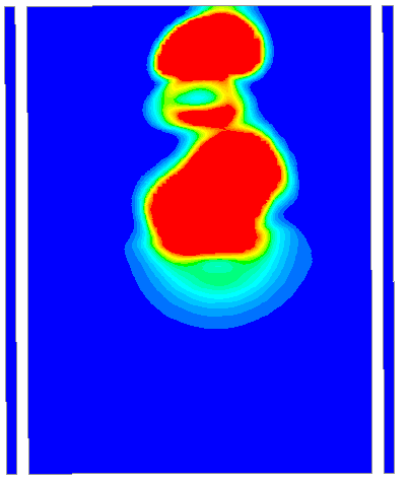


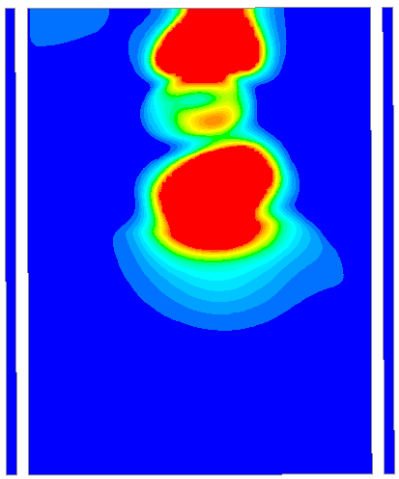


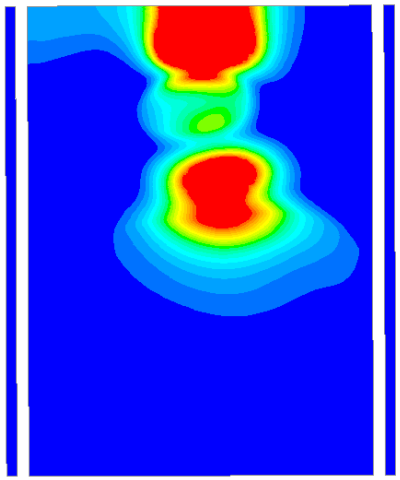


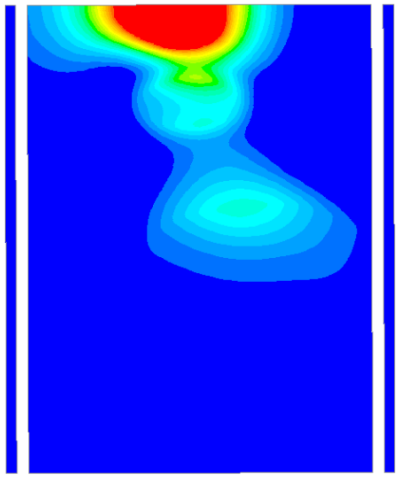




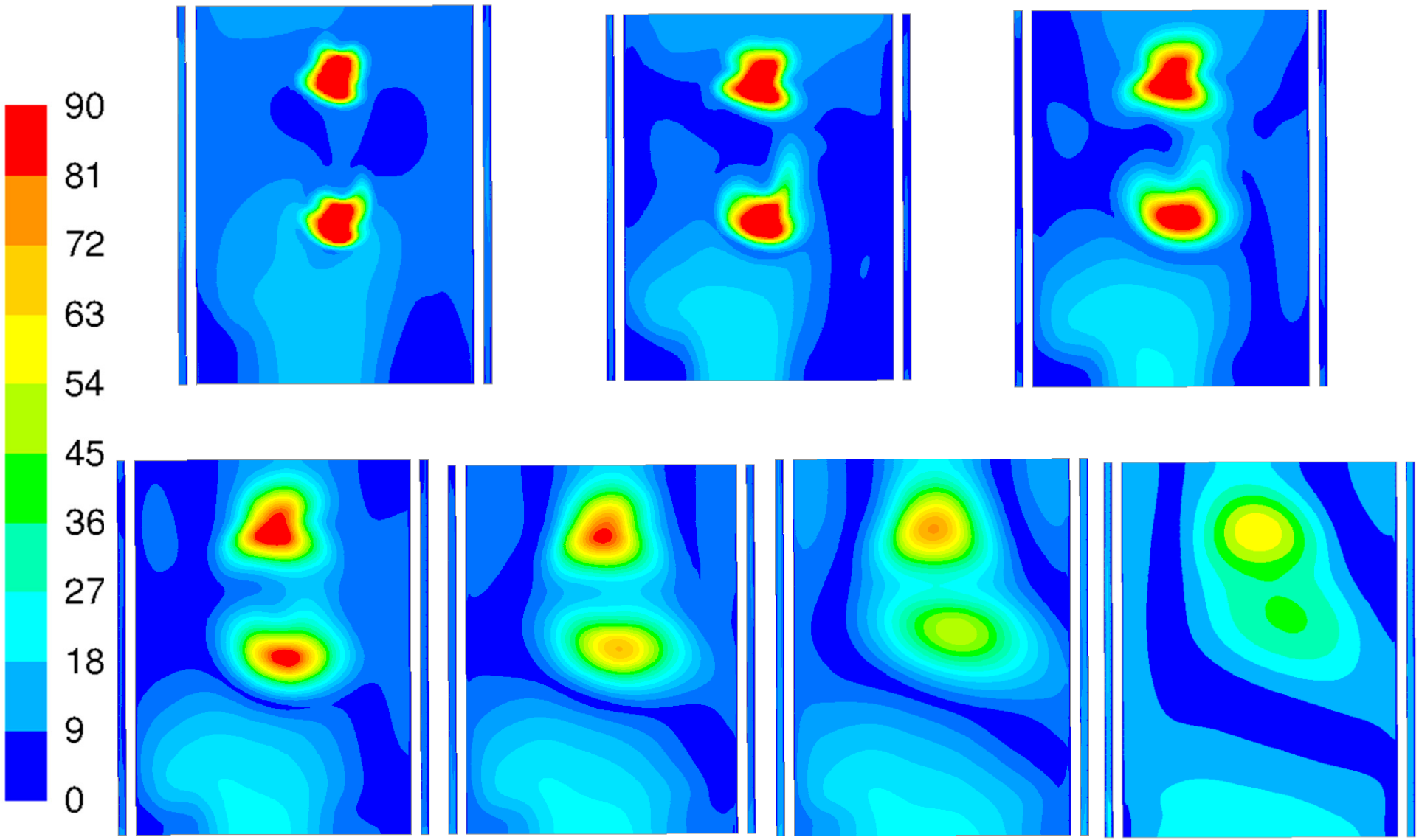




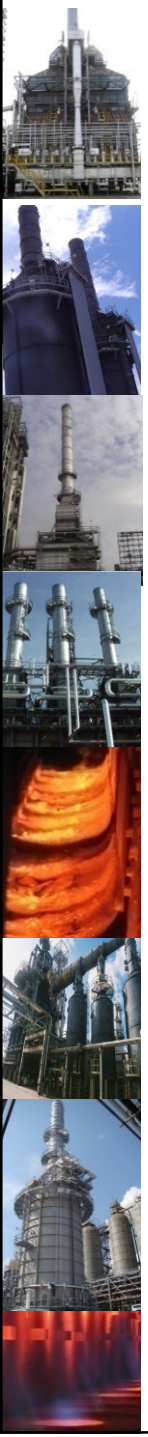


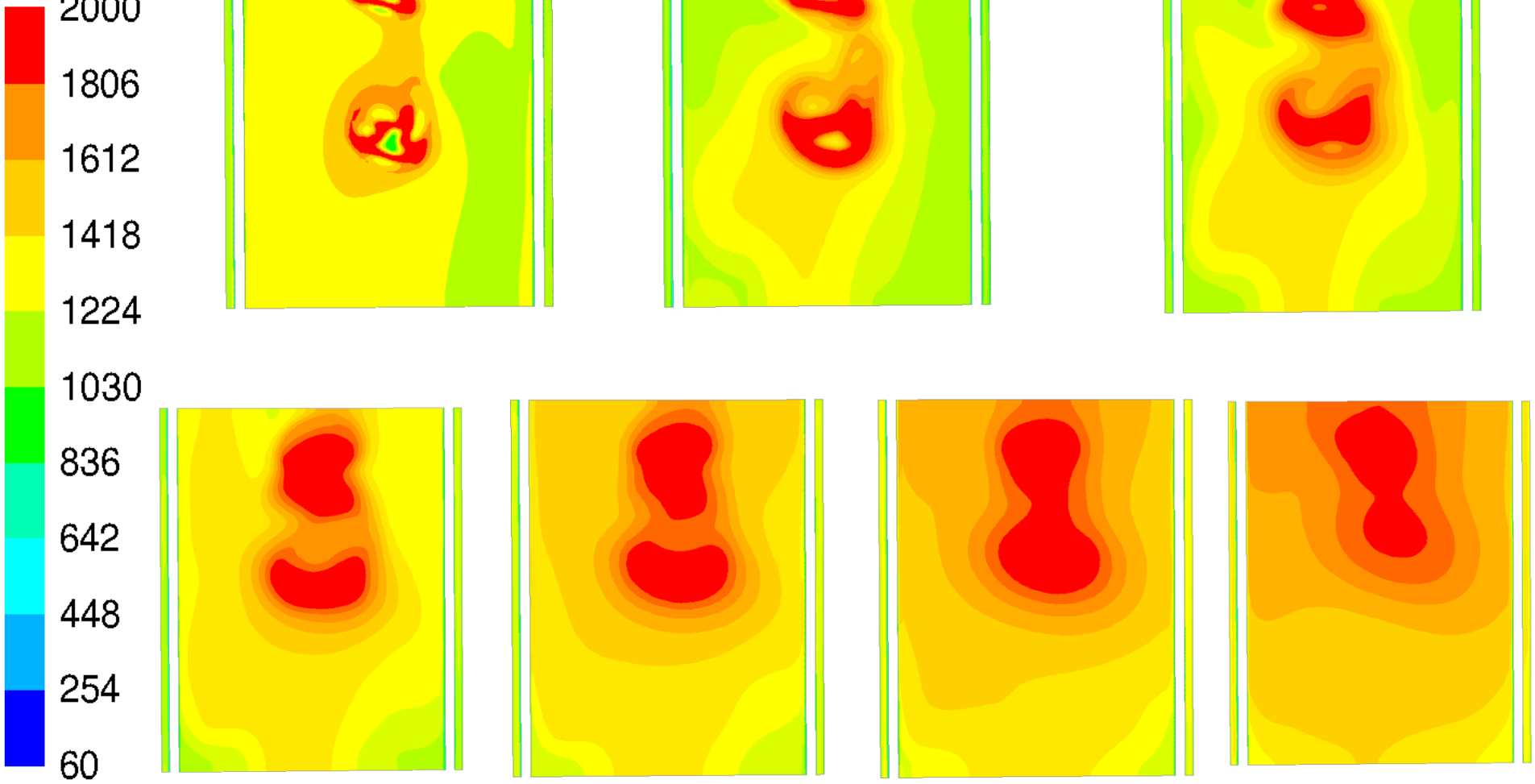


Velocity Contours at Different Elevations of Heater

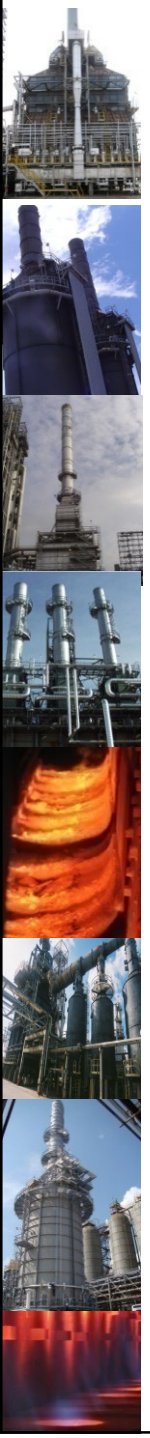


Temperature Contours at Different Elevations of Heater





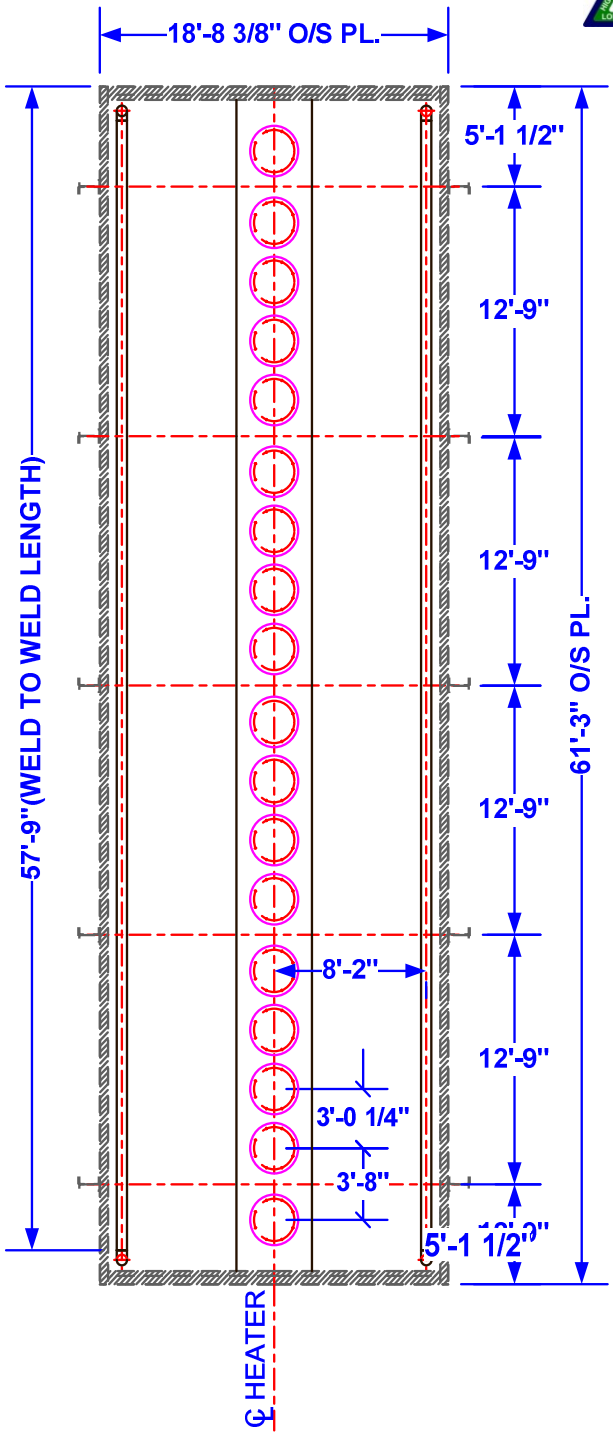
Base Case



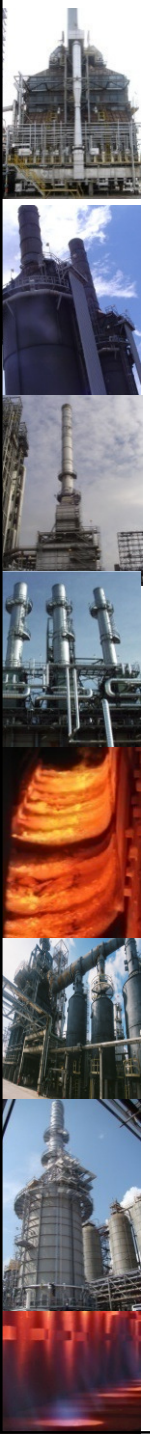
	Bottom Zone	Intermediate Zone	Top Zone	Mean Value
Radiation Heat Flux $(\frac{BTU}{hr.ft^2})$	-7429.83	-10071.1	-11350.2	-
Total Heat Flux $(\frac{BTU}{hr.ft^2})$	-8387.7	-11426.3	-14735.2	-11825
Heat Flux % Variation from mean	-29.06	-3.36	24.62	-

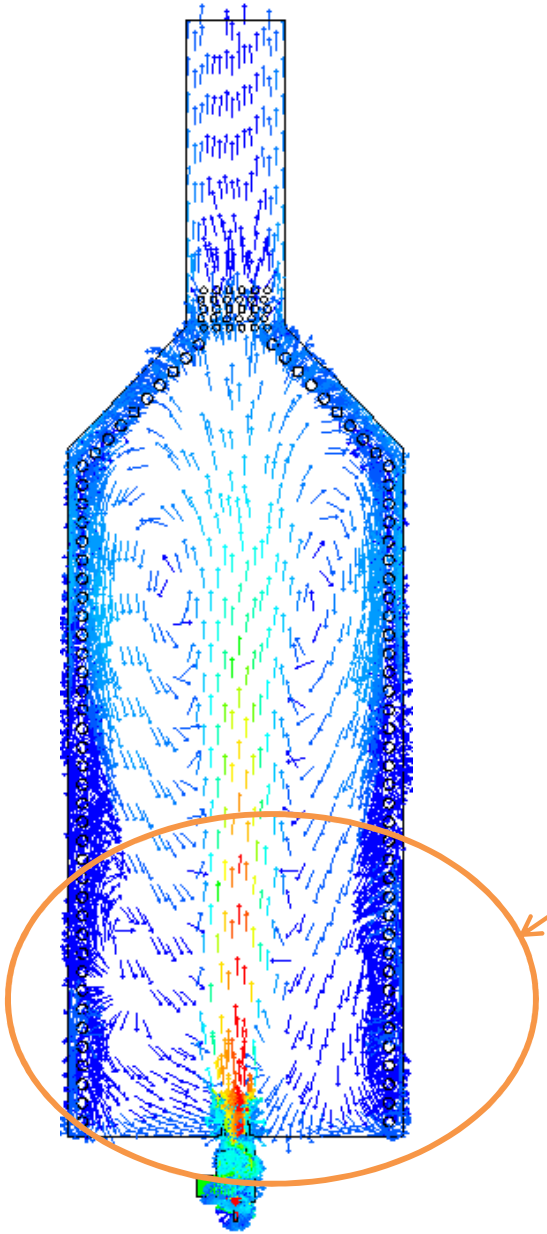
Proposed Option 18 Ultra Low NOx Burners

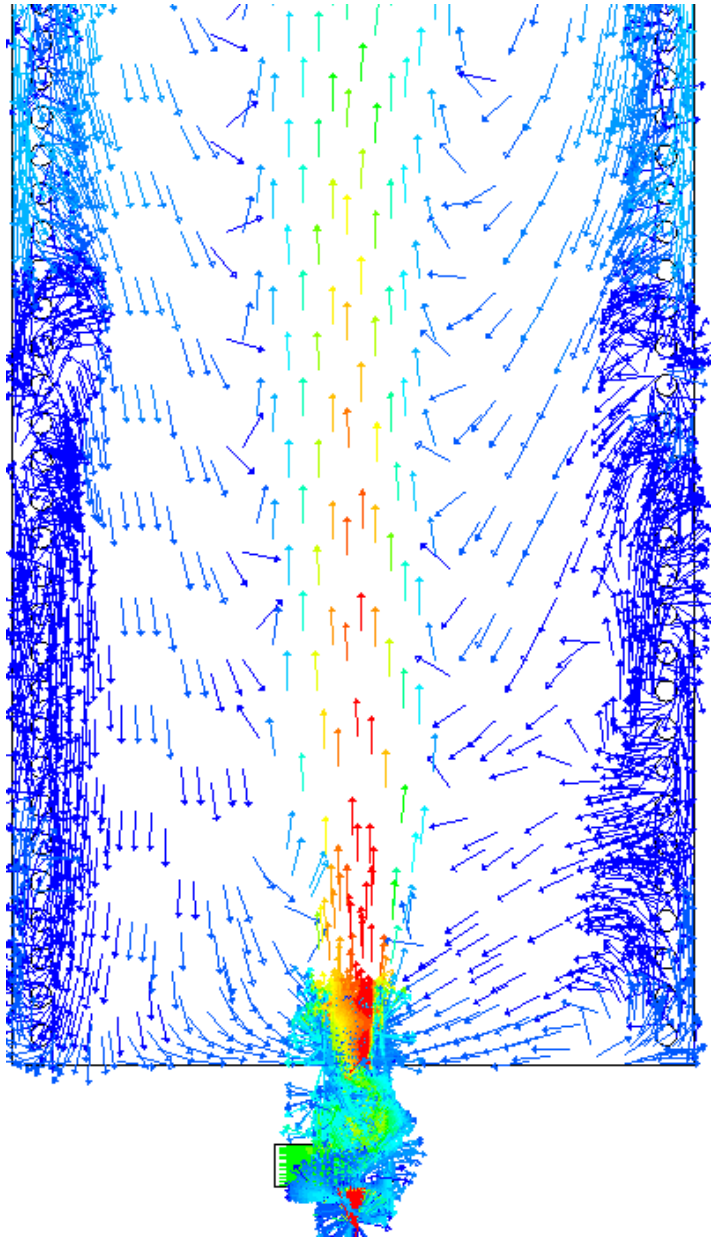
Parameters	Unit	Existing
No. of Burners	Nos.	6
Heat Released/Burner (Max)	MMBtu/hr	12.96
Flame Length	ft	18-20
Burner to Burner Distance	ft	3



Velocity vectors at Y-1 Section(ft/s)

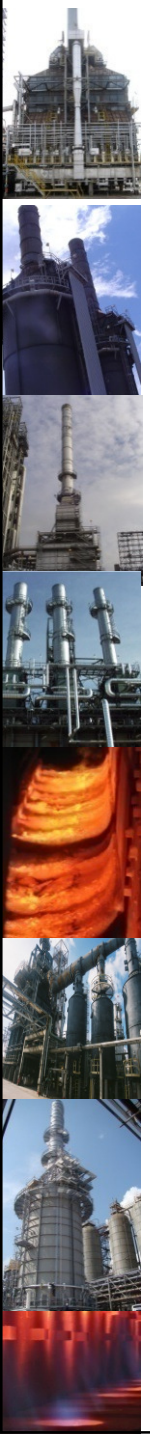


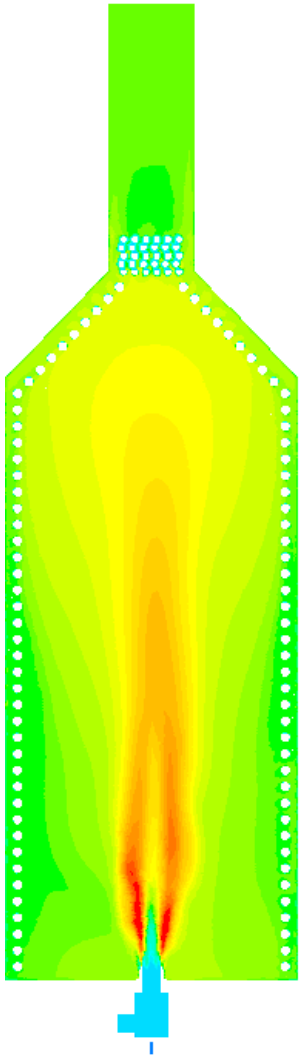




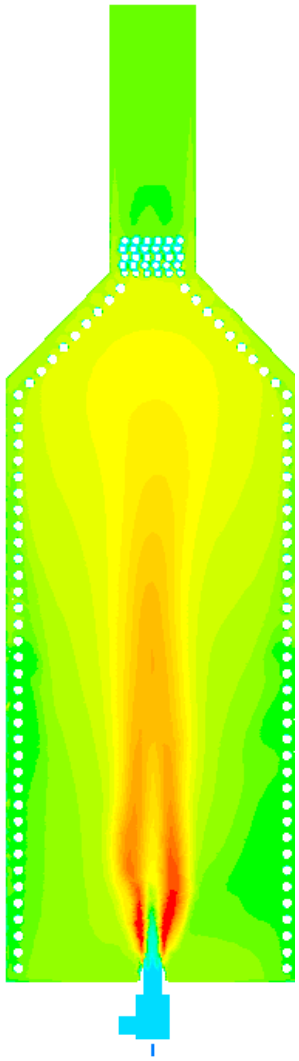
Zoomed view

Temperature contours at Y Section(deg F)



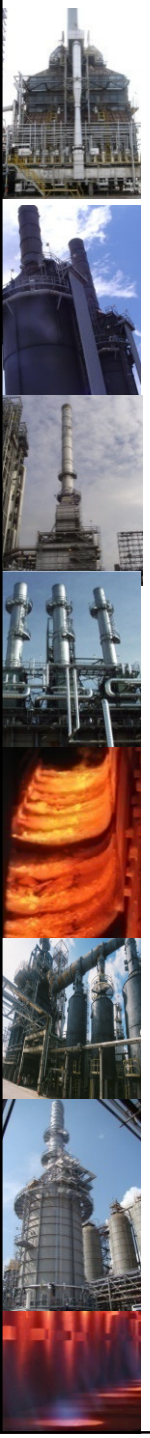


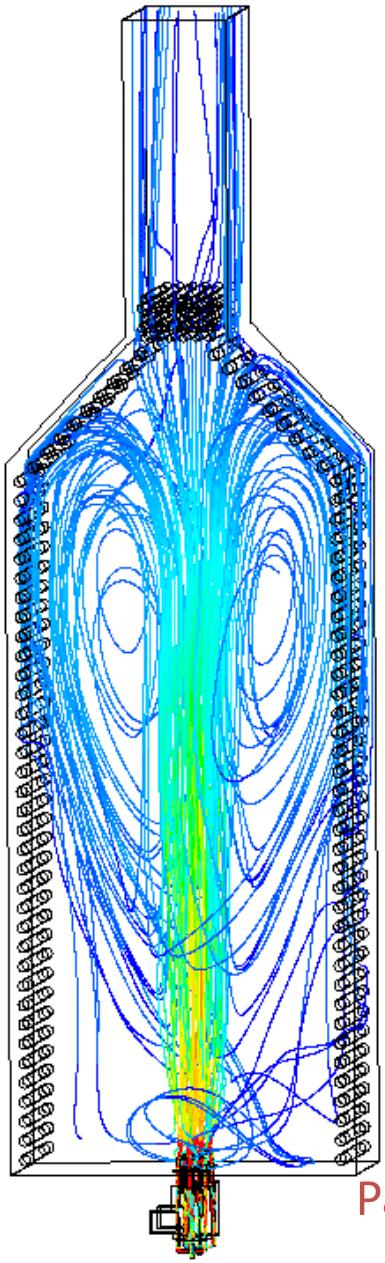
Y-1 section

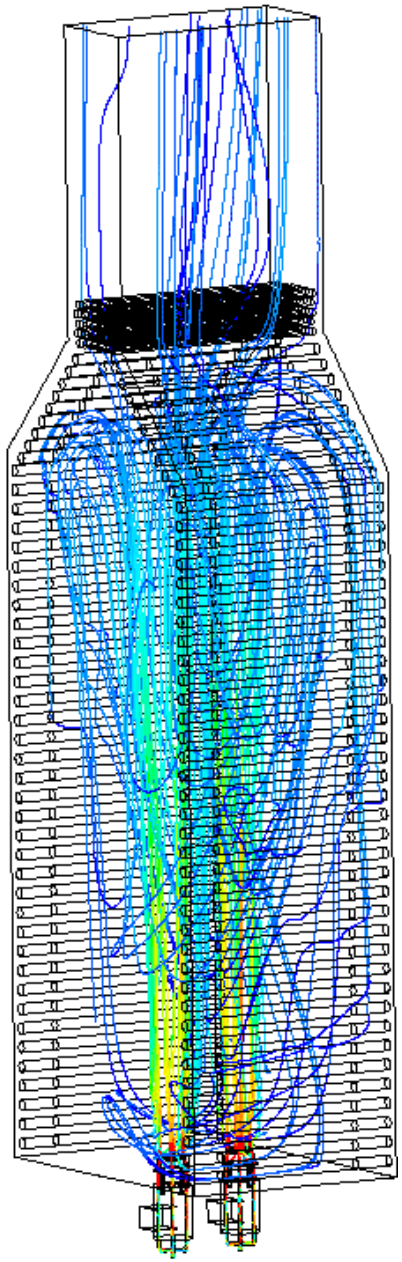


Y-2 section

Pathlines colored by velocity (ft/s)

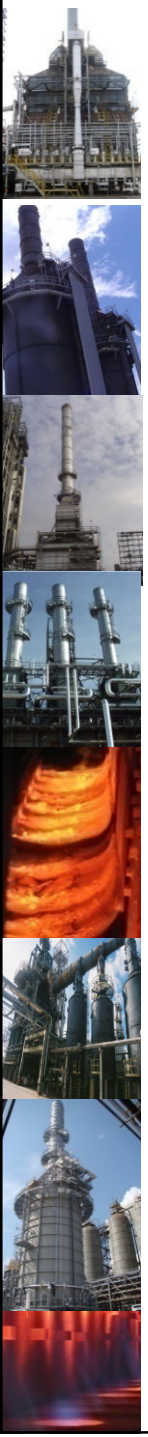


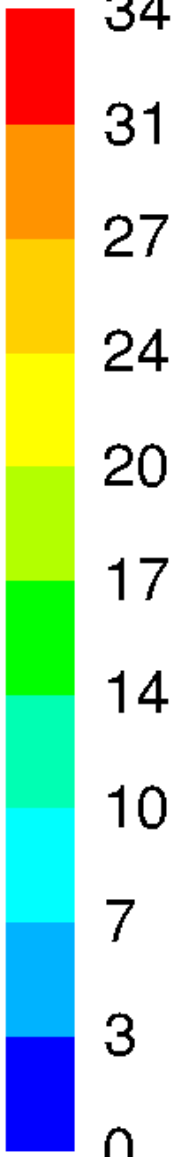


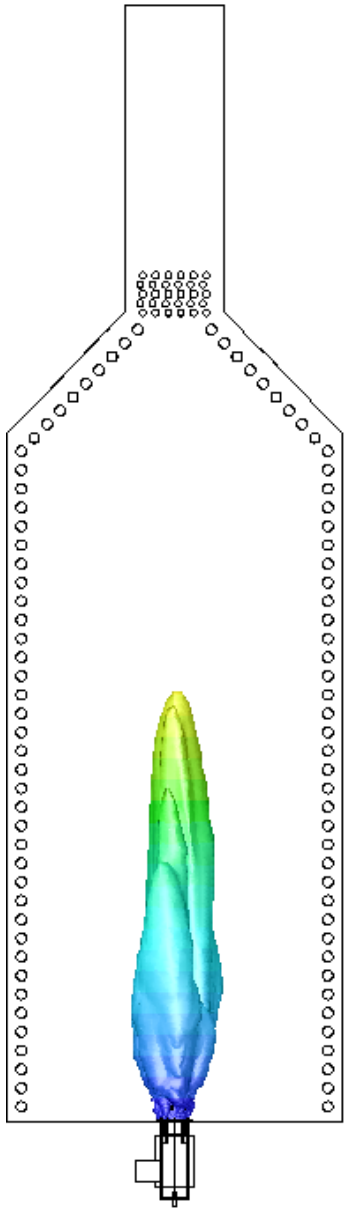


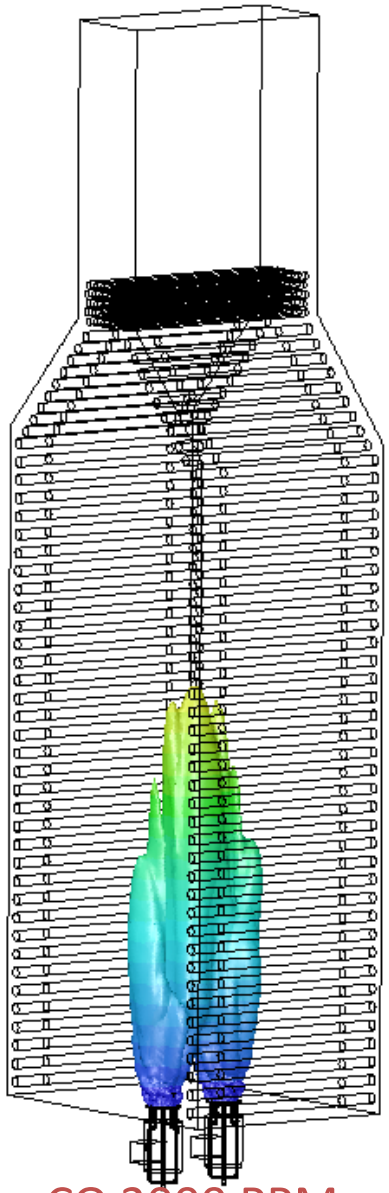
Pathlines released from burner fuel tip

Flame colored by height (ft)

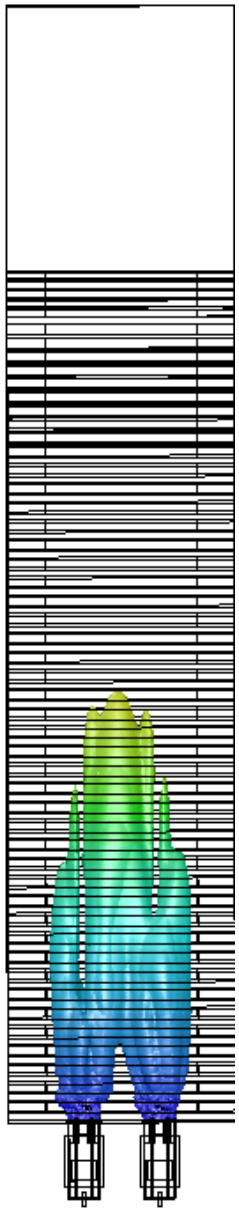




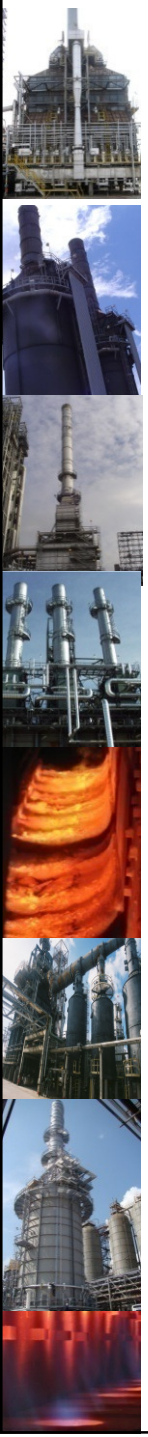


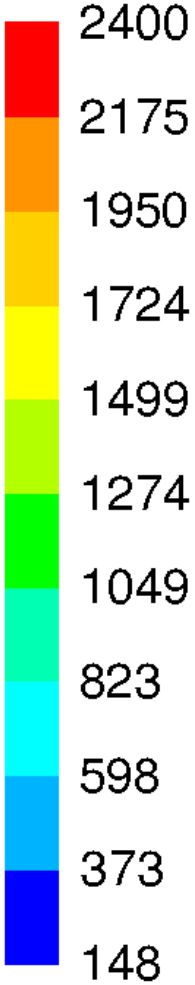


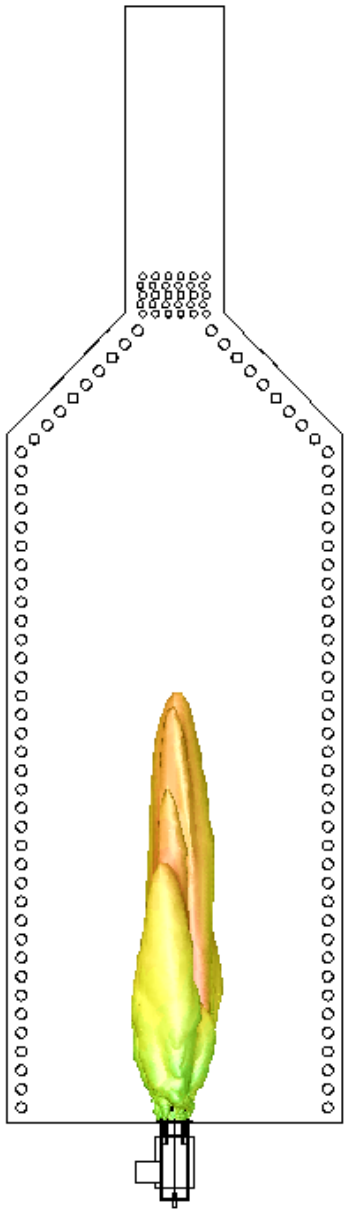
CO 2000 PPM

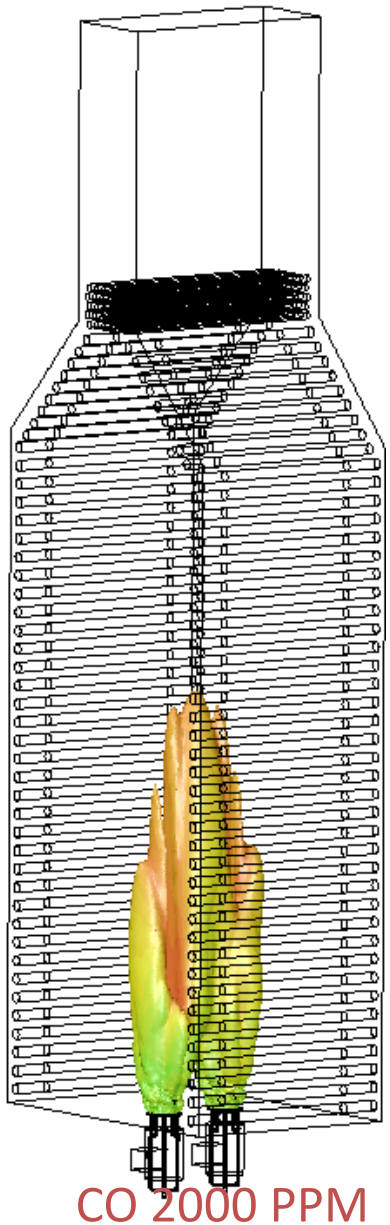


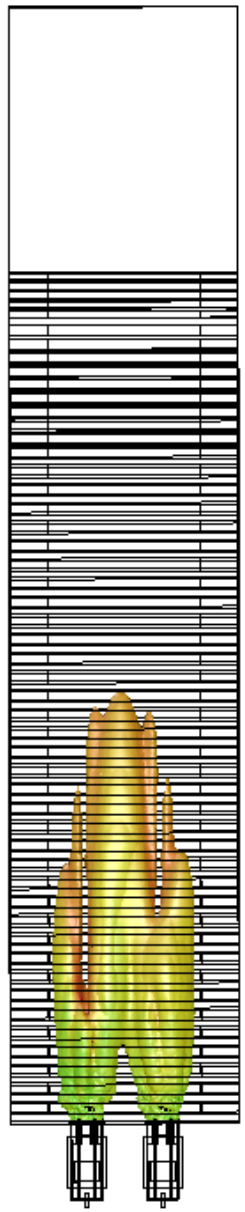
Flame colored by Temperatures (deg F)





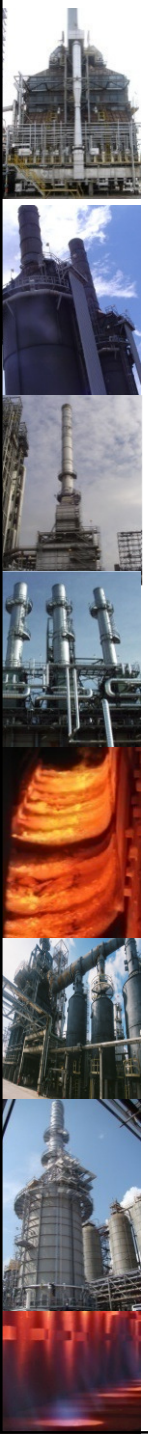


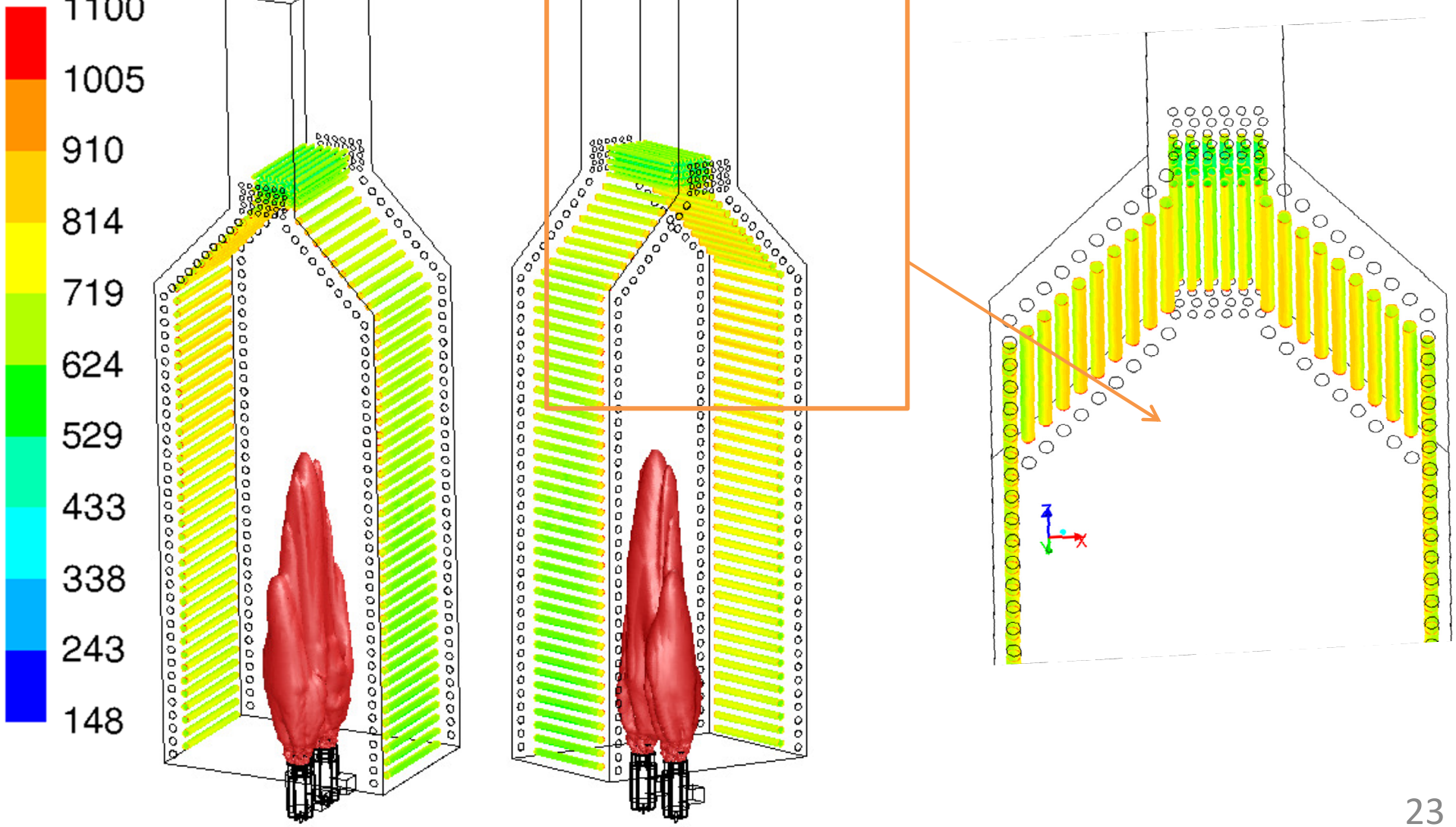




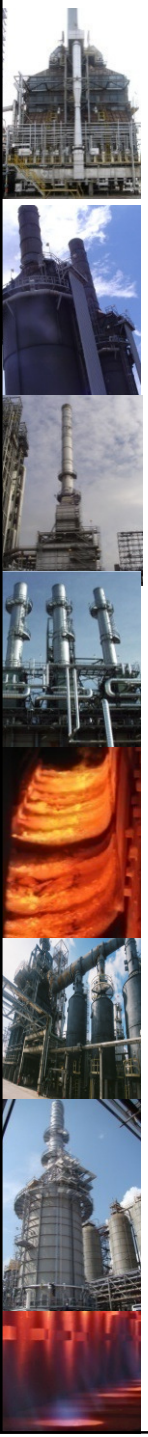
CO 2000 PPM

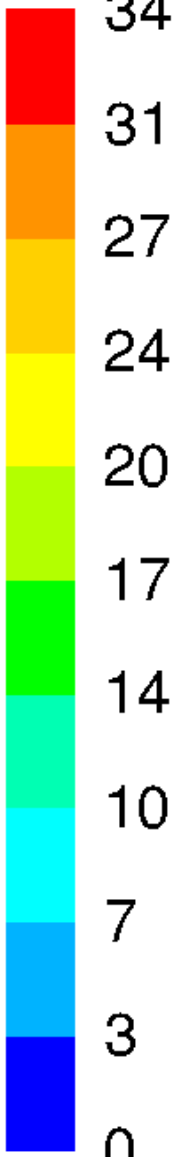
Radiant Tubes Temperature Contours (deg F)

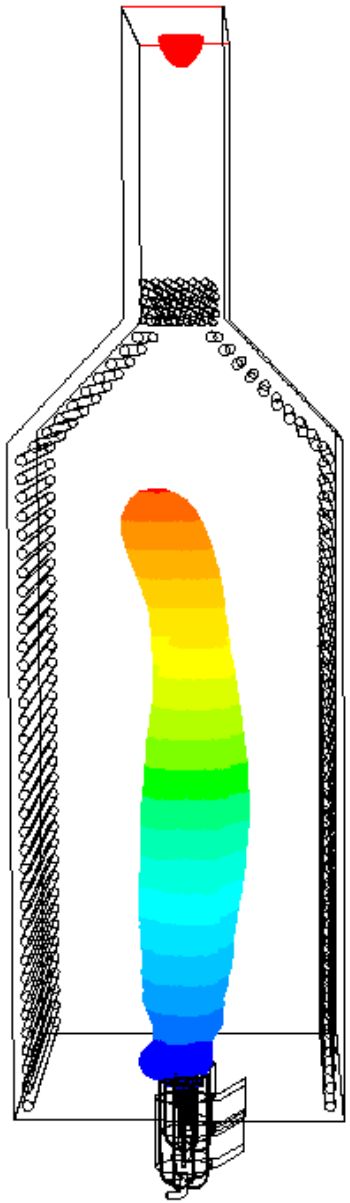




Flame colored by height (ft)

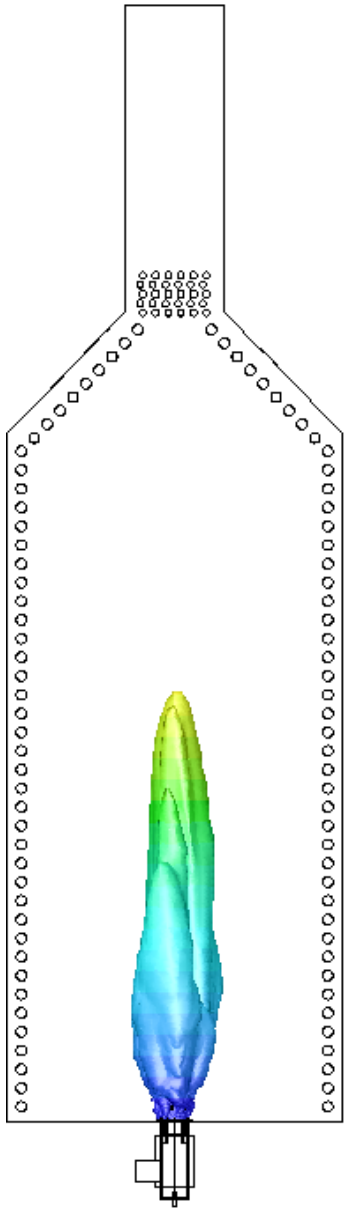






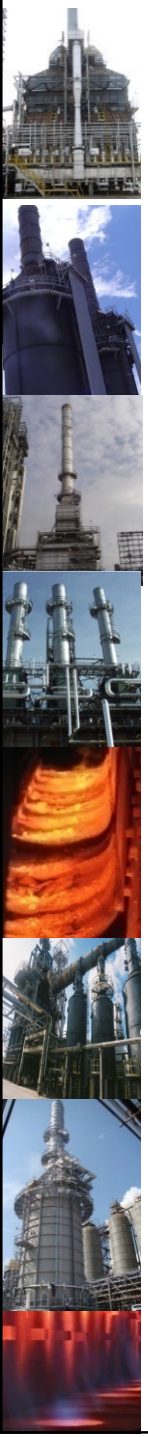
Base Case

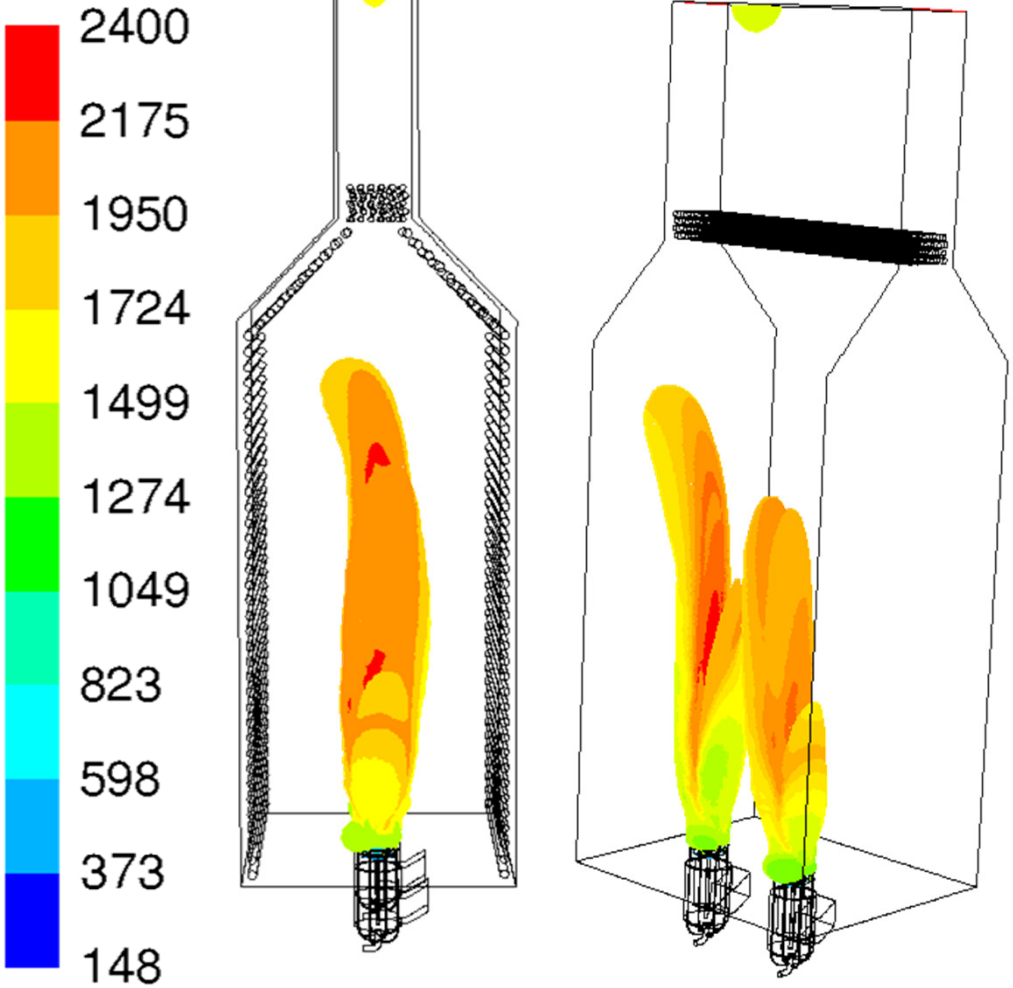
CO 2000 PPM



Proposed Design

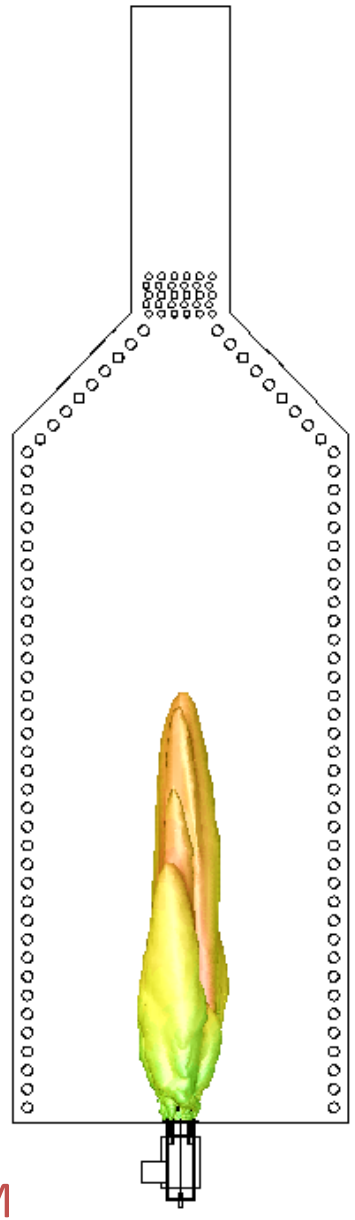
Flame colored by Temperatures (deg F)



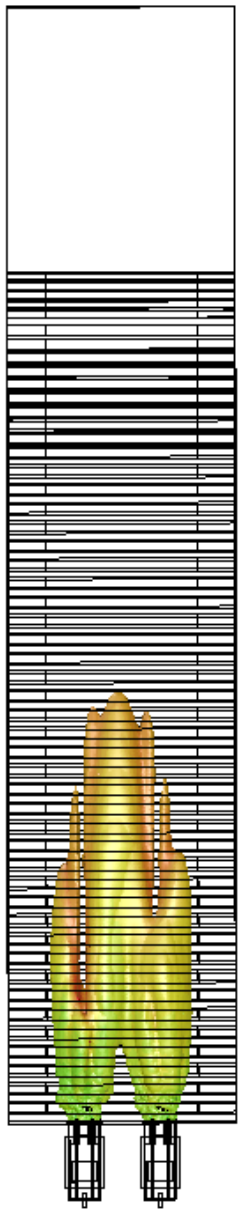


Base Case

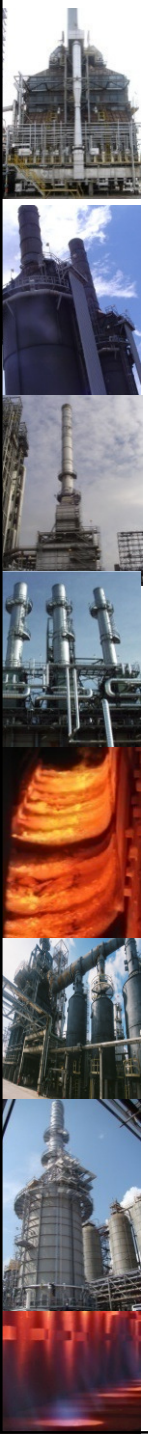
CO 2000 PPM

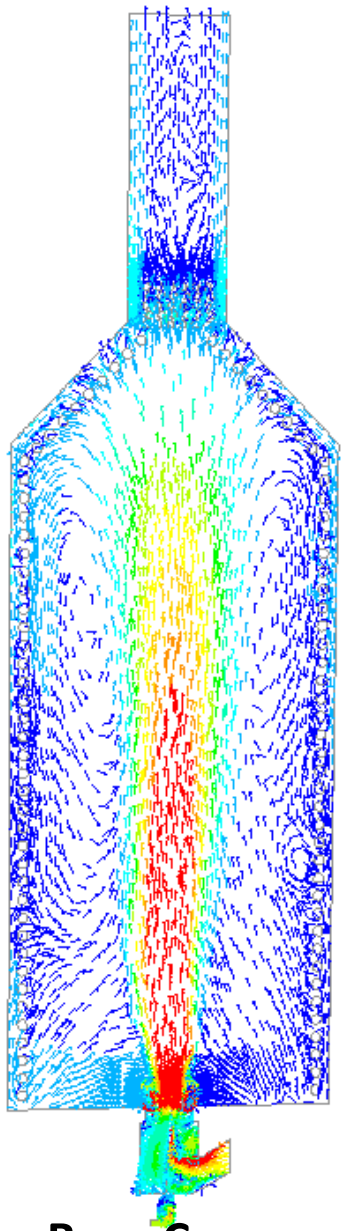


Proposed Design

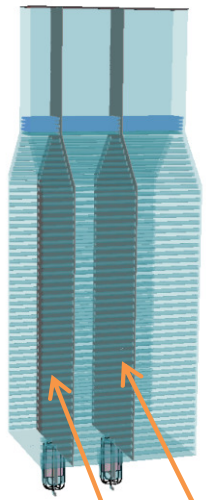


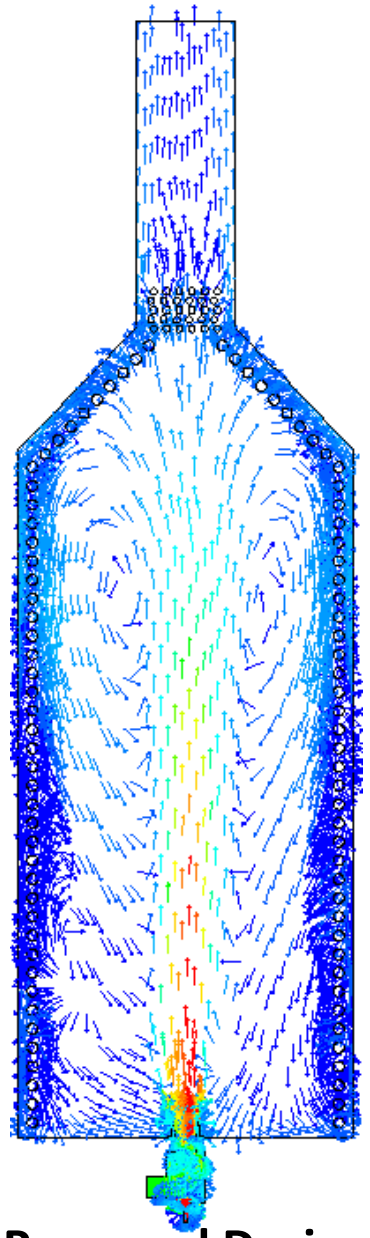
Velocity Vectors at Vertical Section(ft/s)



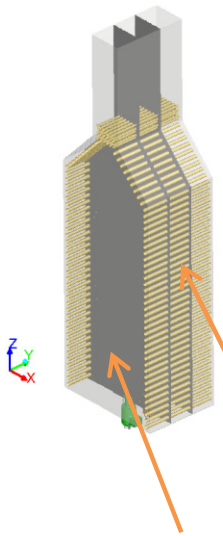


Base Case

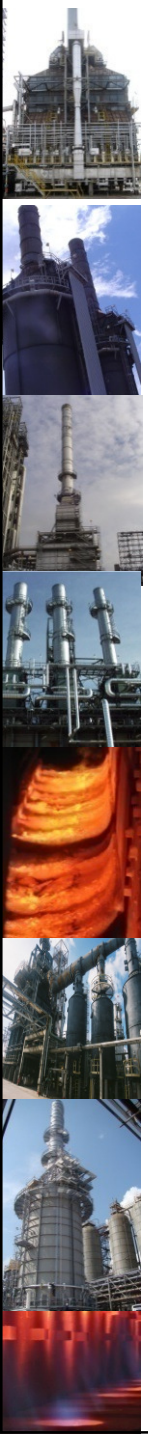


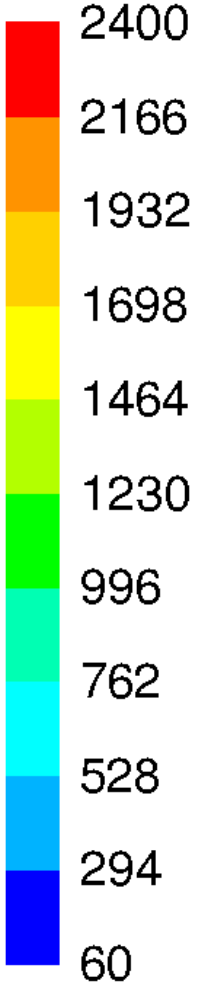


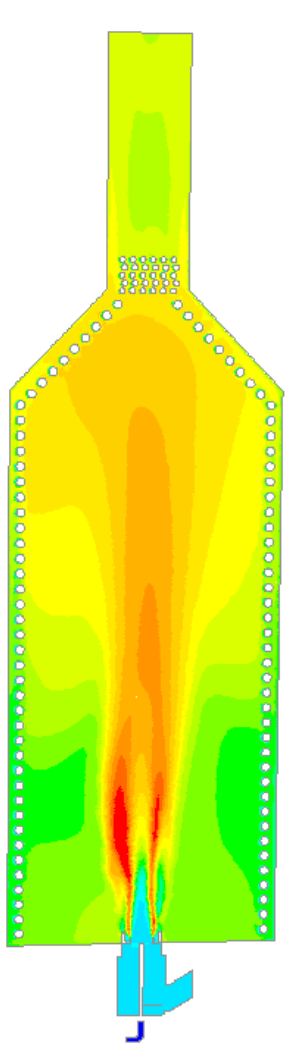
Proposed Design



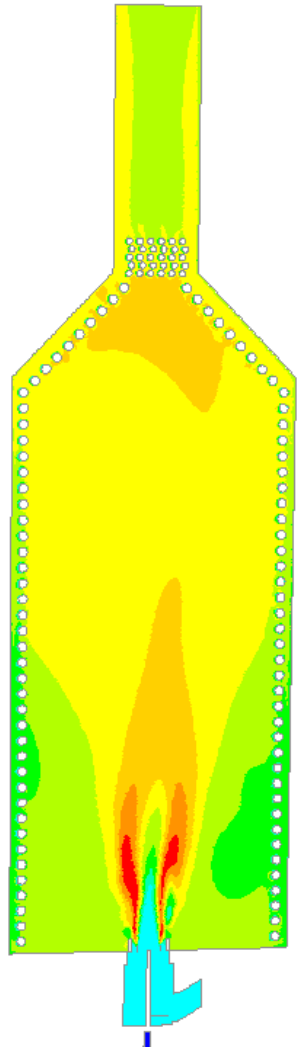
Temperature contours at Z Section (deg F)





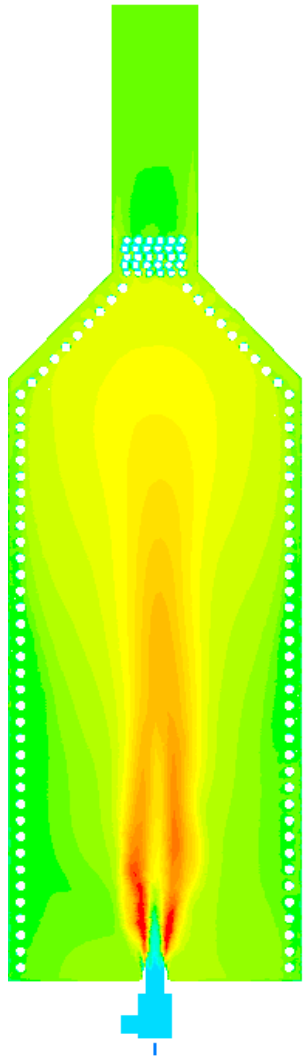


Z-1 section

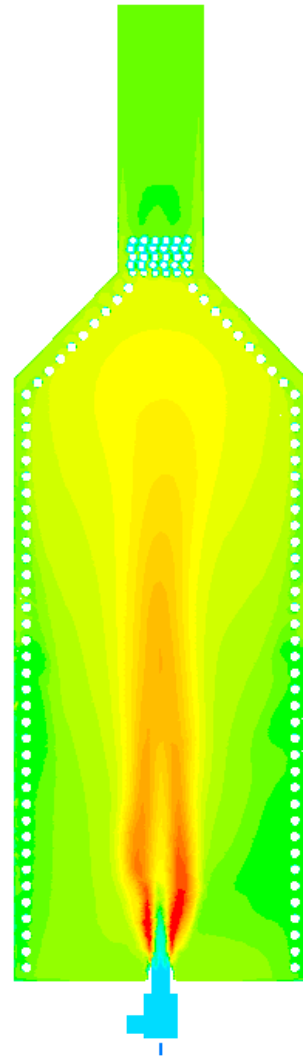


Z-2 section

Base Case



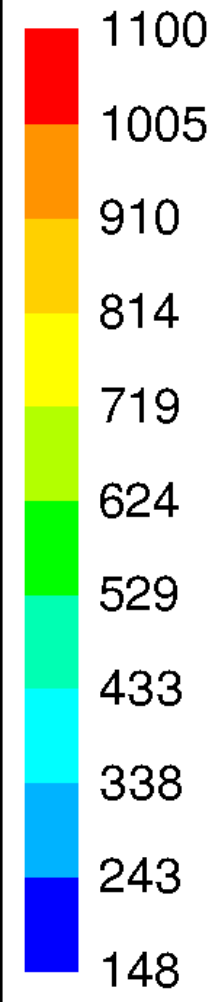
Y-1 section

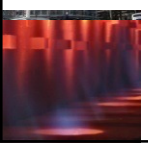


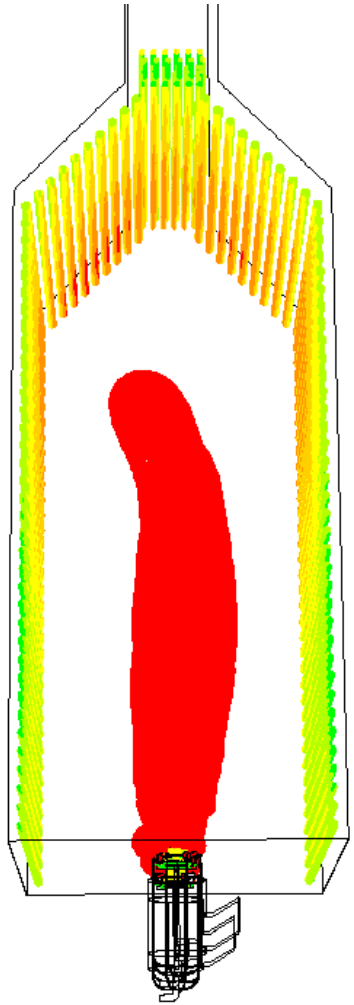
Y-2 section

Proposed Design

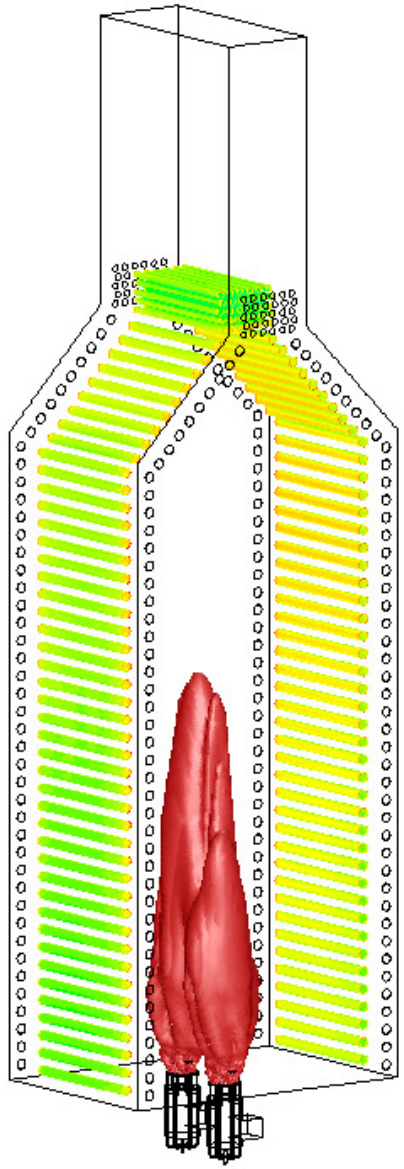
Radiant Tubes Temperature Contours (deg F)

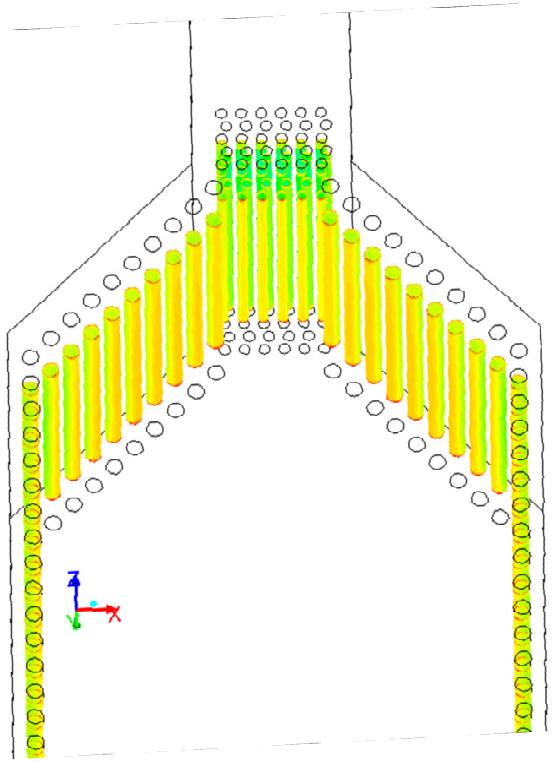






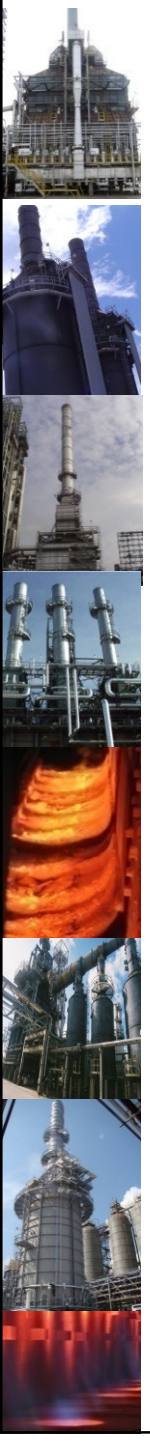
Base Case





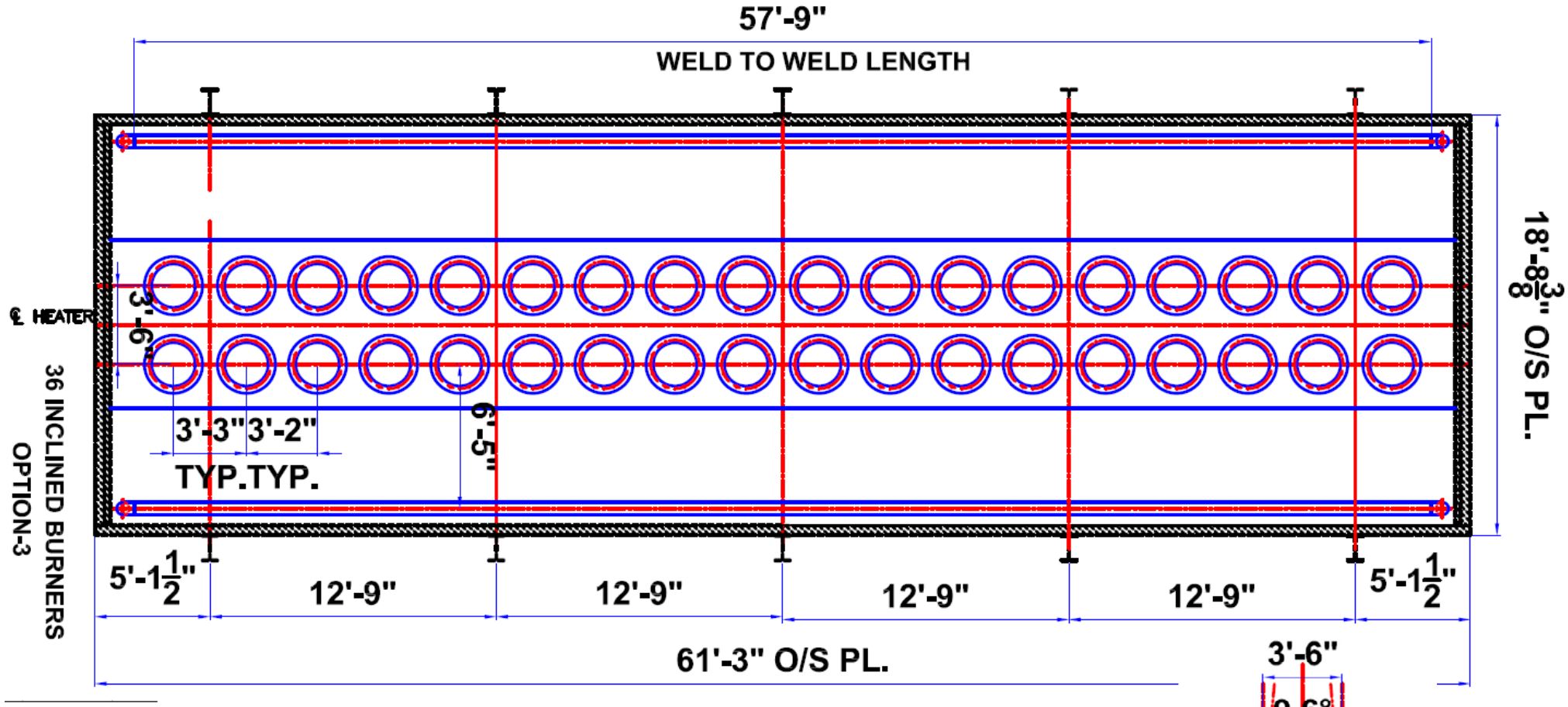
Proposed Design

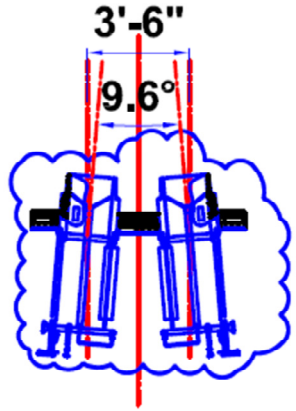
Mod-18 Burners Case

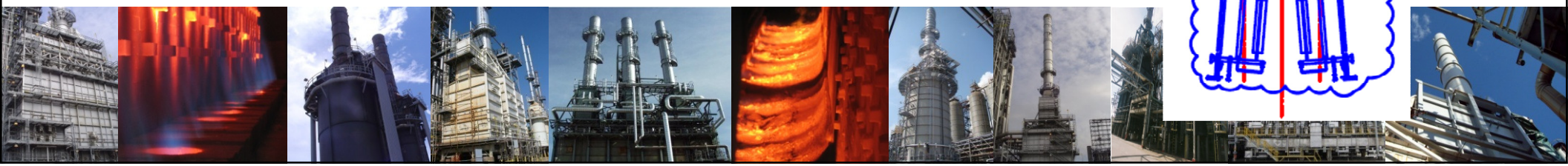


	Bottom Zone	Intermediate Zone	Top Zone	Mean Value
Radiation Heat Flux $(\frac{BTU}{hr.ft^2})$	-8283.96	-10029.5	-10824	-
Total Heat Flux $(\frac{BTU}{hr.ft^2})$	-9469.57	-11288.8	-13123.9	-11416
Heat Flux % Variation from mean	-17.1	-1.1	15	-

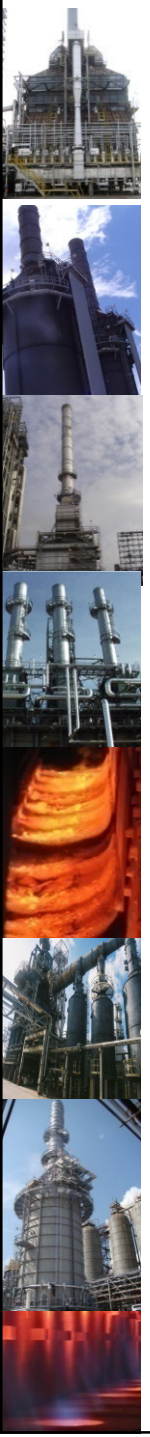
Option 3 – 36 Inclined Burners

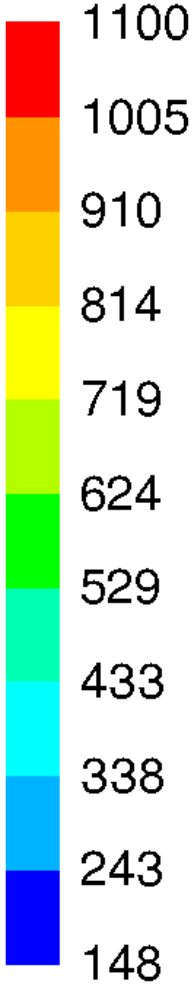


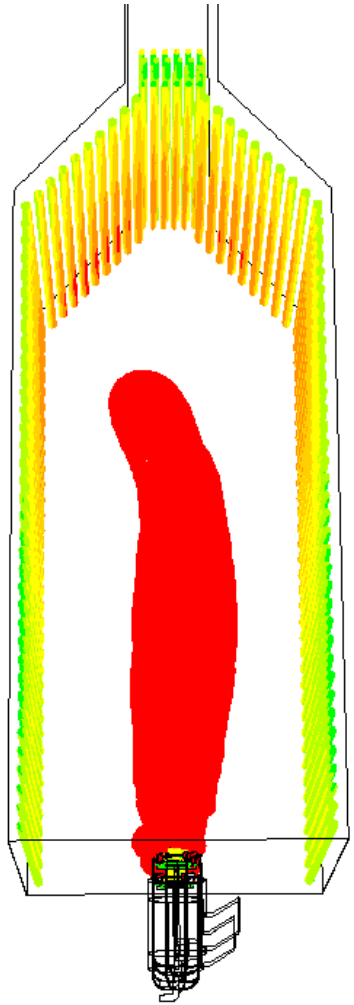




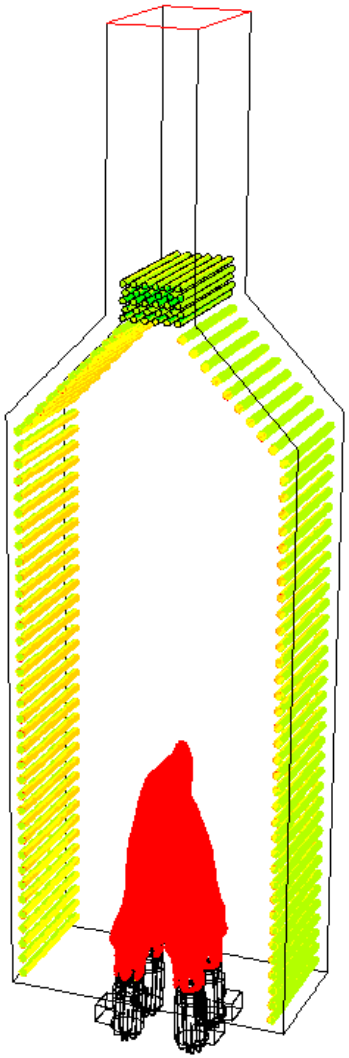
Radiant Tubes Temperature Contours (deg F)

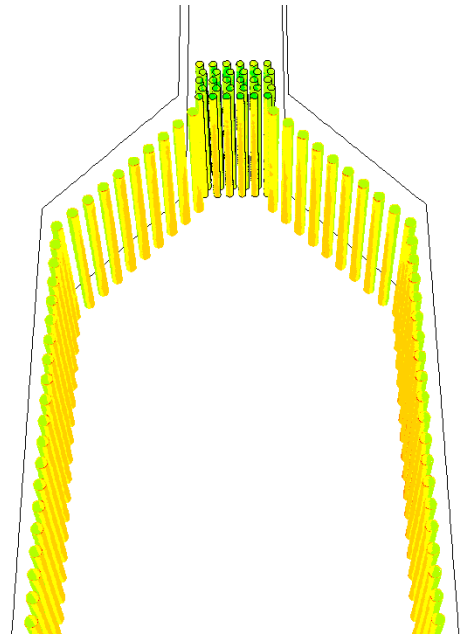






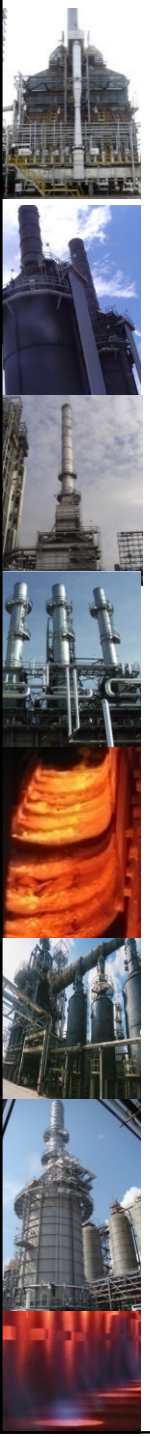
Base Case





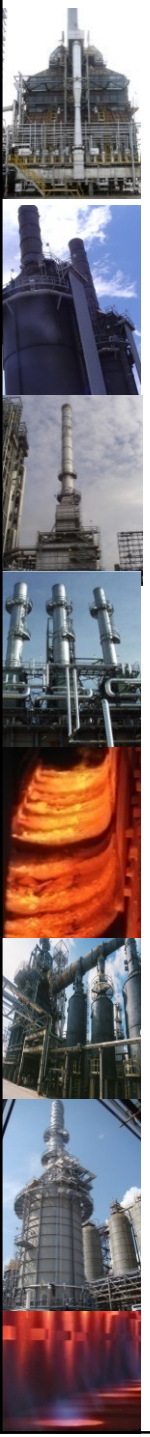
Proposed Design

Process Parameters



- Low fluid mass velocity in the radiant tubes
  - Existing - 155 lb/sec ft^2
  - Recommended- 250-350 lb/sec ft^2
- Pressure drop across the crude heater service is low
  - Existing - 53 psi
  - Recommended pressure drop is around 100-150 psi
- Convection tube size is 4 inch and radiant tube is 6 inch.
  - Typically one size difference between the two.

Summary



- The heater was commissioned in January 2014.
- Client is extremely happy with the heater performance.
- They would have preferred to go with 36 burners as an afterthought.
- The run length increased to 1.5 years (estimated based on temperature rise)
- Process modifications have been put off.

Thank You

Questions and Comments are Welcome