

Use of Numerical Modeling in Air System Design and Analysis

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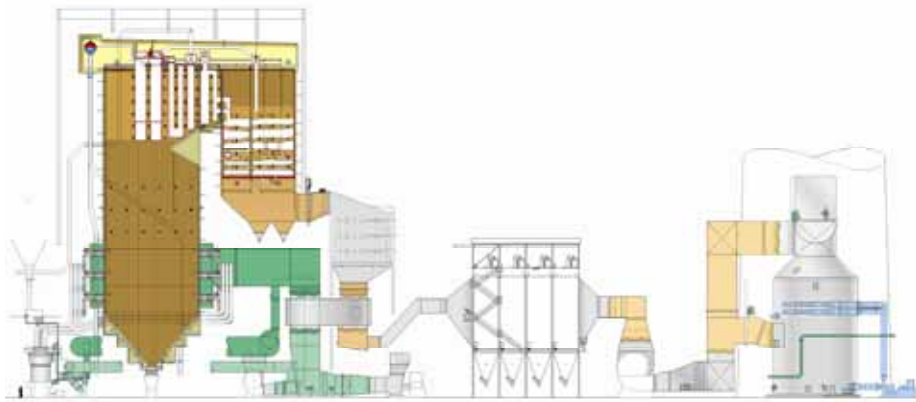


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Modeling Boilers and Related Equipment

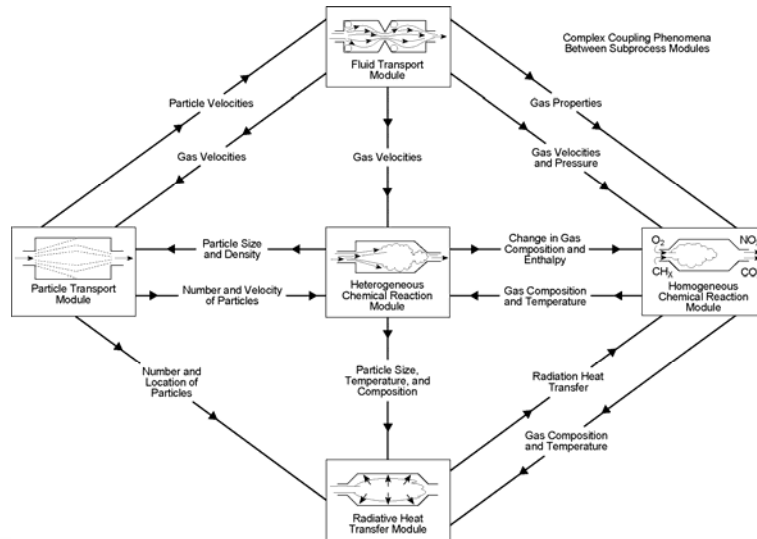


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Coal Combustion Modeling



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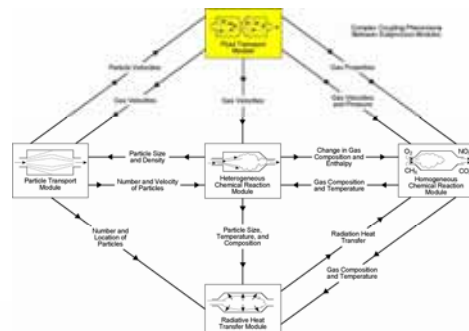


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Fluid Transport

- Time Averaged Transport Equations
- Steady State
- $k-\epsilon$ Turbulence Model
- Energy Transport
- Species Transport



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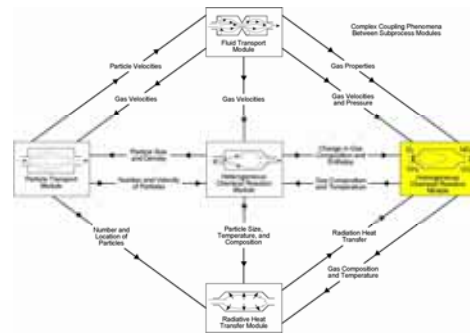


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Homogeneous Combustion

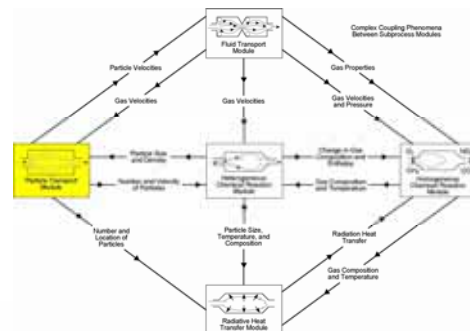
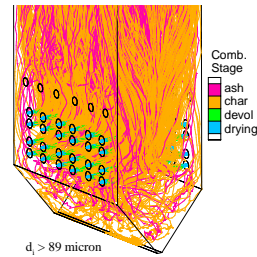
- EDM and EDC Combustion models
- Chemical Kinetics
- Turbulent Interactions
- Multiply Species and Steps



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Particle Transport

- Flow, Heat Transfer and Combustion
- Lagrangian-Turbulent Particle Dispersion
- Eulerian-Advection with Turbulent diffusion
- Hybrid (Lag. and Eul.)

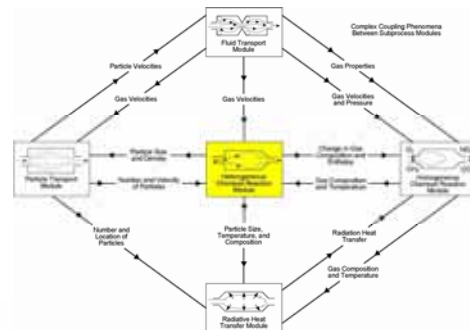


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Heterogeneous Combustion

- **Drying**
- **Devolatilization**
- **Char Oxidation**
- **Inorganic Transformations**
- **Surface Reactions**

Combustion Stage	Coal	Oil	Wood	Black Liquor
Drying / Evap	X	X	X	X
Devolatilization	X		X	X
Char Burning	X	X	X	X
Inorganic Transformations				X

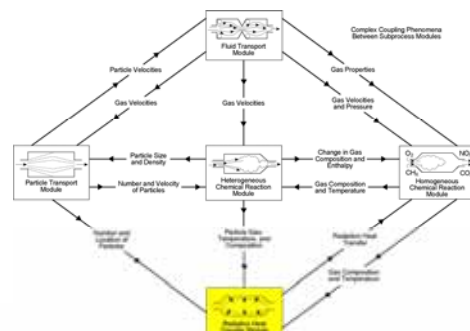


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Radiative Heat Transfer

- **Gray or Spectral Radiation**
- **Absorption and Scattering**
- **Thermal and Radiative Properties**
- **Gases**
- **Particles**
- **Deposits**



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Background and Objective

- ***775 MW Coal Fired Boiler***
- ***Reduce NOx Emissions***
- ***New Low-NOx Burners***
- ***New Over-Fire Air System***

Determine Best Over-Fire Air Design Option

- ***CO emissions***
- ***Flow Uniformity***

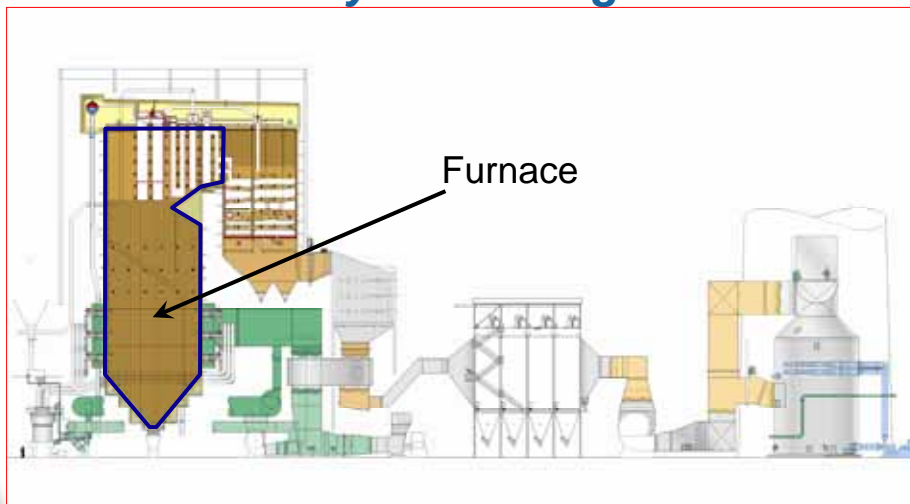


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Over-Fire Air System Design

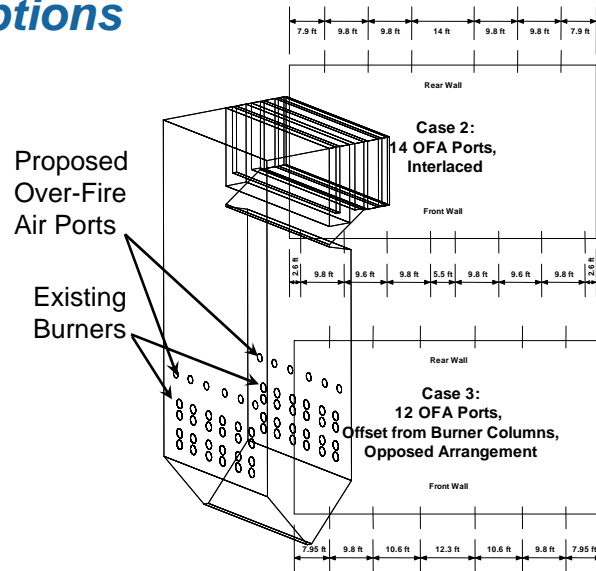


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Design Options



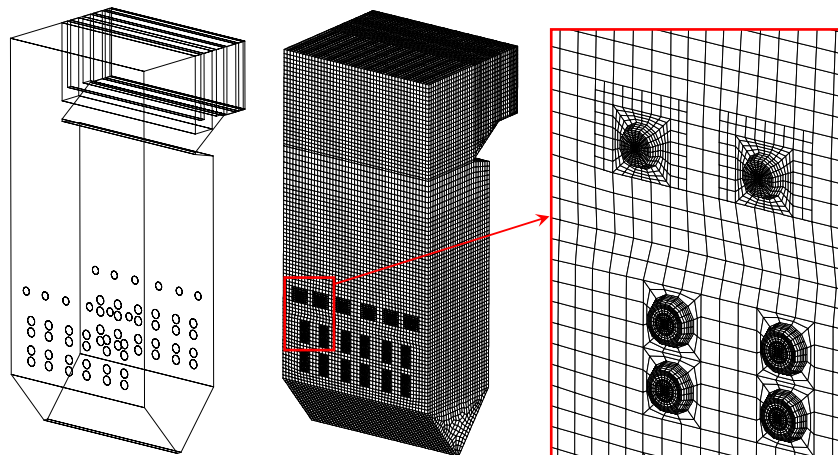
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Furnace Mesh



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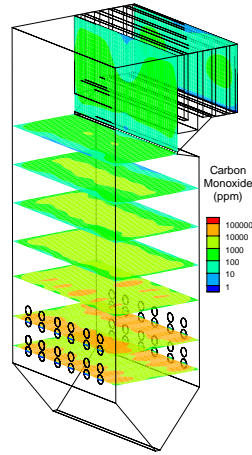


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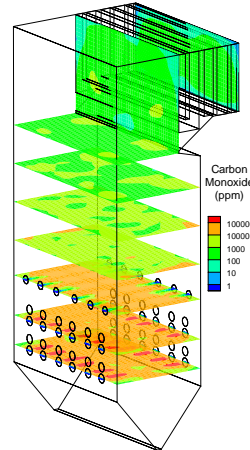
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Study Results



Before



After

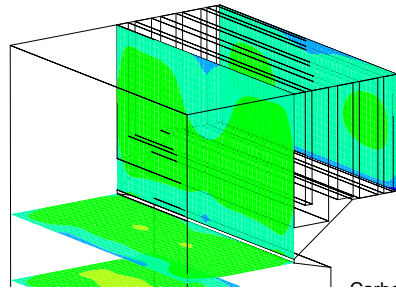
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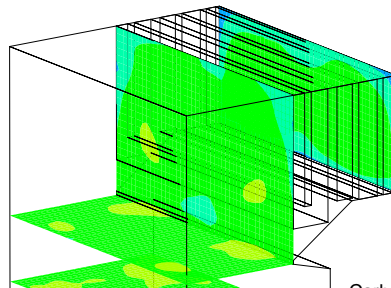
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Study Results



Before



After

Case No.	CO (ppm dry @ 3% O ₂)
1	179
2	417
3	380

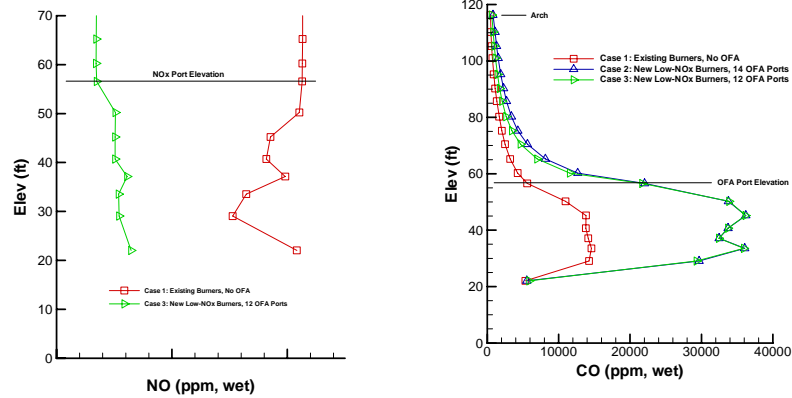
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Study Results



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Study Background and Objective

- 1100 MW Coal Fired Boiler
- 80 (40/wall) Individual Burners
- Improve Burner Performance/Balance

Optimize Windbox Design

- Burner-to-Burner Air Imbalance
- Wall-to-Wall Imbalance
- Cost

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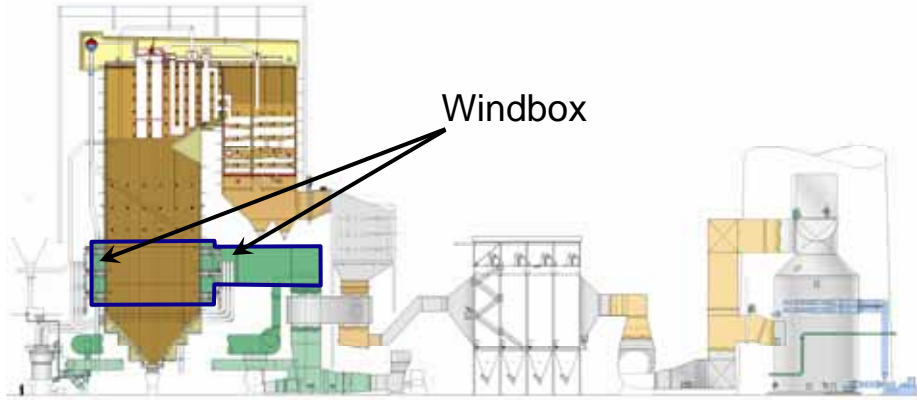


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Windbox Optimization

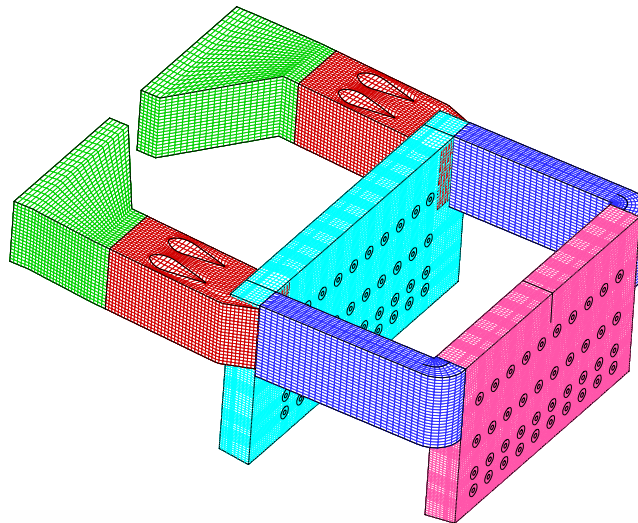


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Windbox Mesh



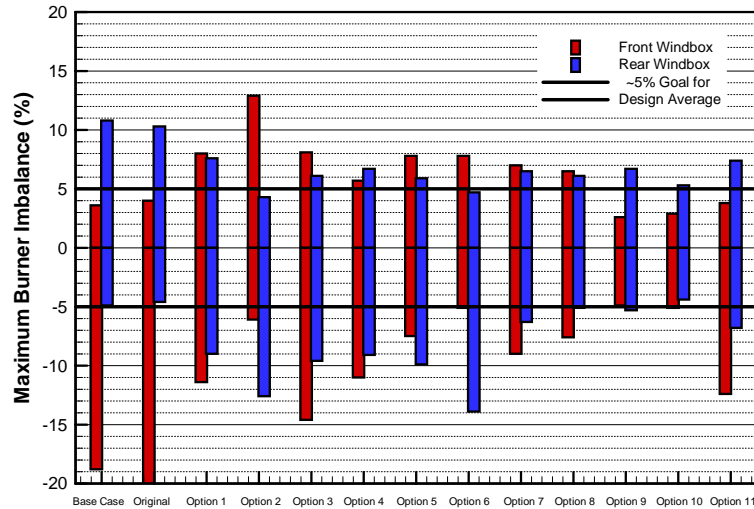
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Results



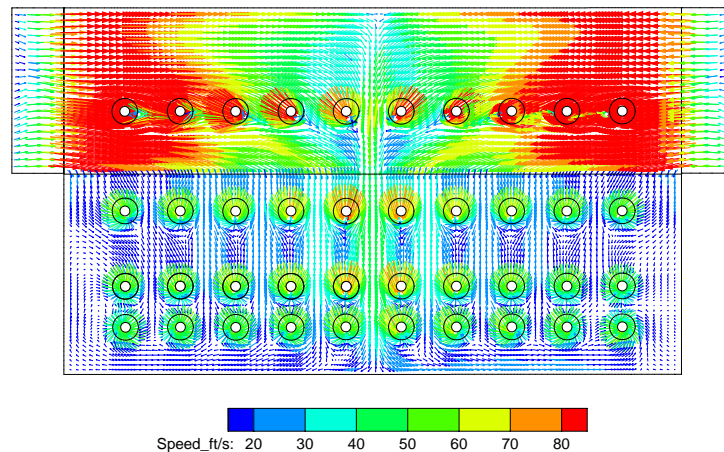
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Original Configuration



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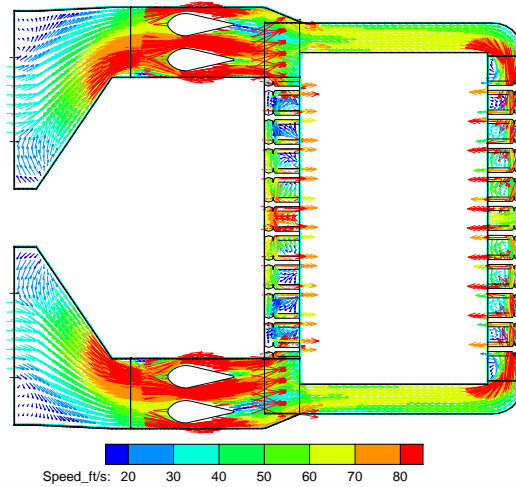


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Original Configuration



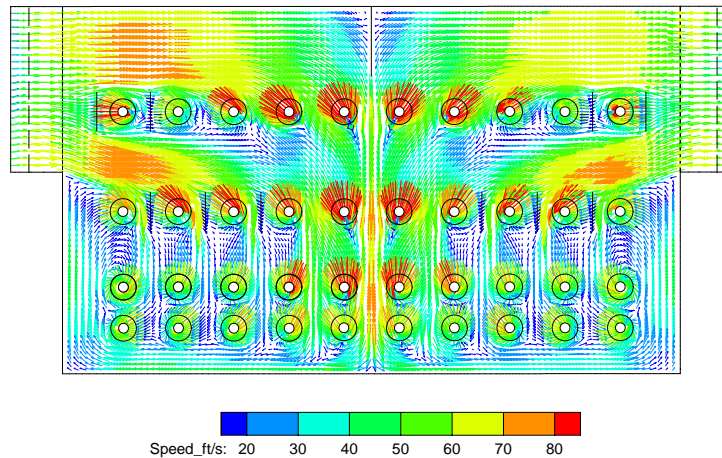
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Optimum Configuration



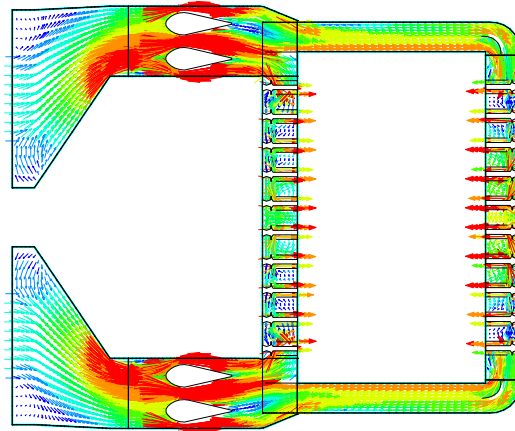
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Optimum Configuration



Speed_ft/s: 20 30 40 50 60 70 80



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Summary

- **Boiler Combustion Model of Over-Fire Air System**
 - Design Evaluation
 - Mixing
 - NO_x Emission Reduction
- **Windbox Flow Model**
 - Design Optimization
 - Flow Imbalances



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Questions



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