Biomass Combustion and Cofiring Issues: An Overview

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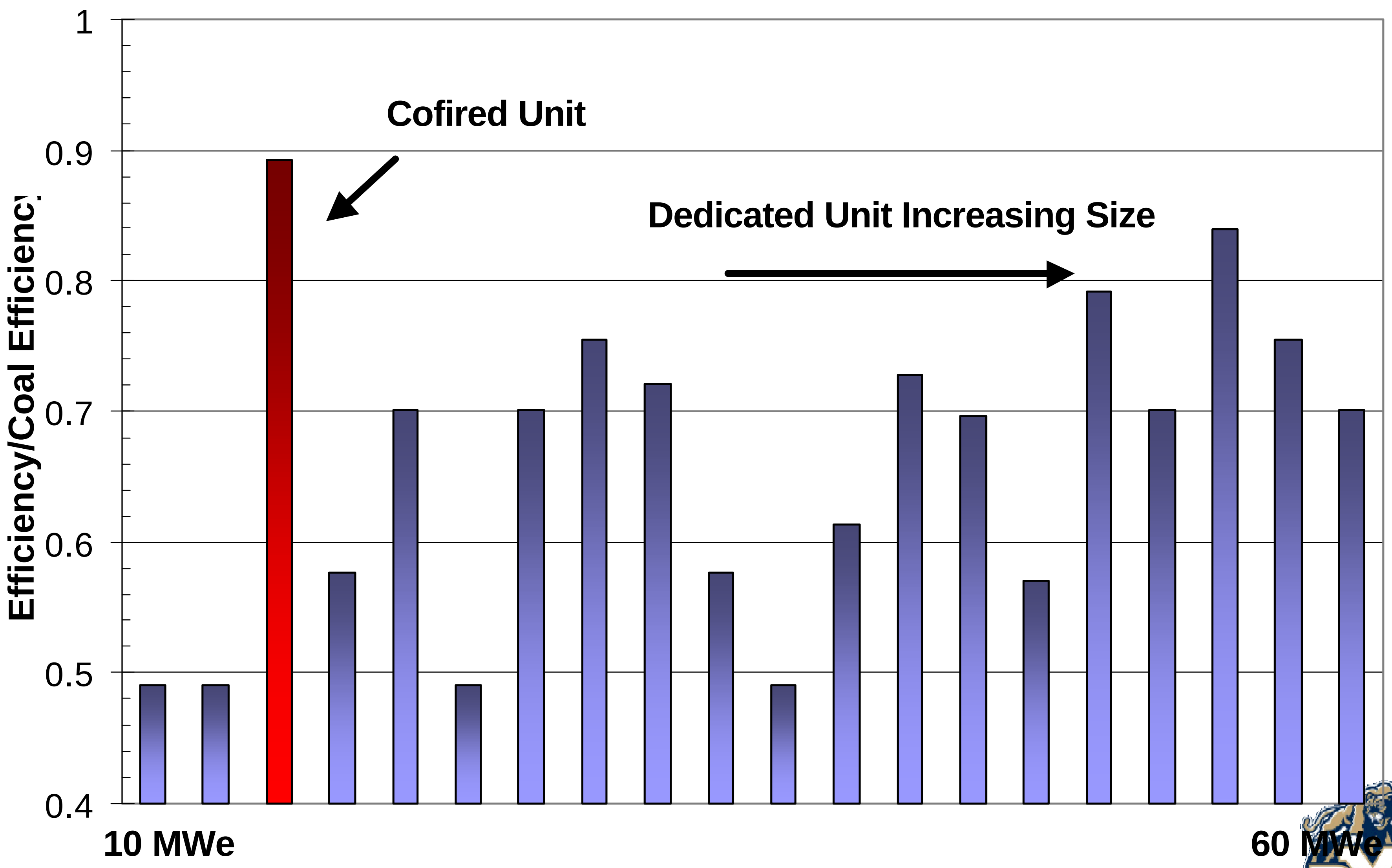
Cofiring Best Uses Resource



Major Technical Cofiring Issues

- **Fireside Issues**
  - **Pollutant Formation**
  - **Carbon Conversion**
  - **Ash Management**
  - **Corrosion**
- **Balance of Process Issues**
  - **Fuel Supply and Storage**
  - **Fuel Preparation**
  - **Ash Utilization**

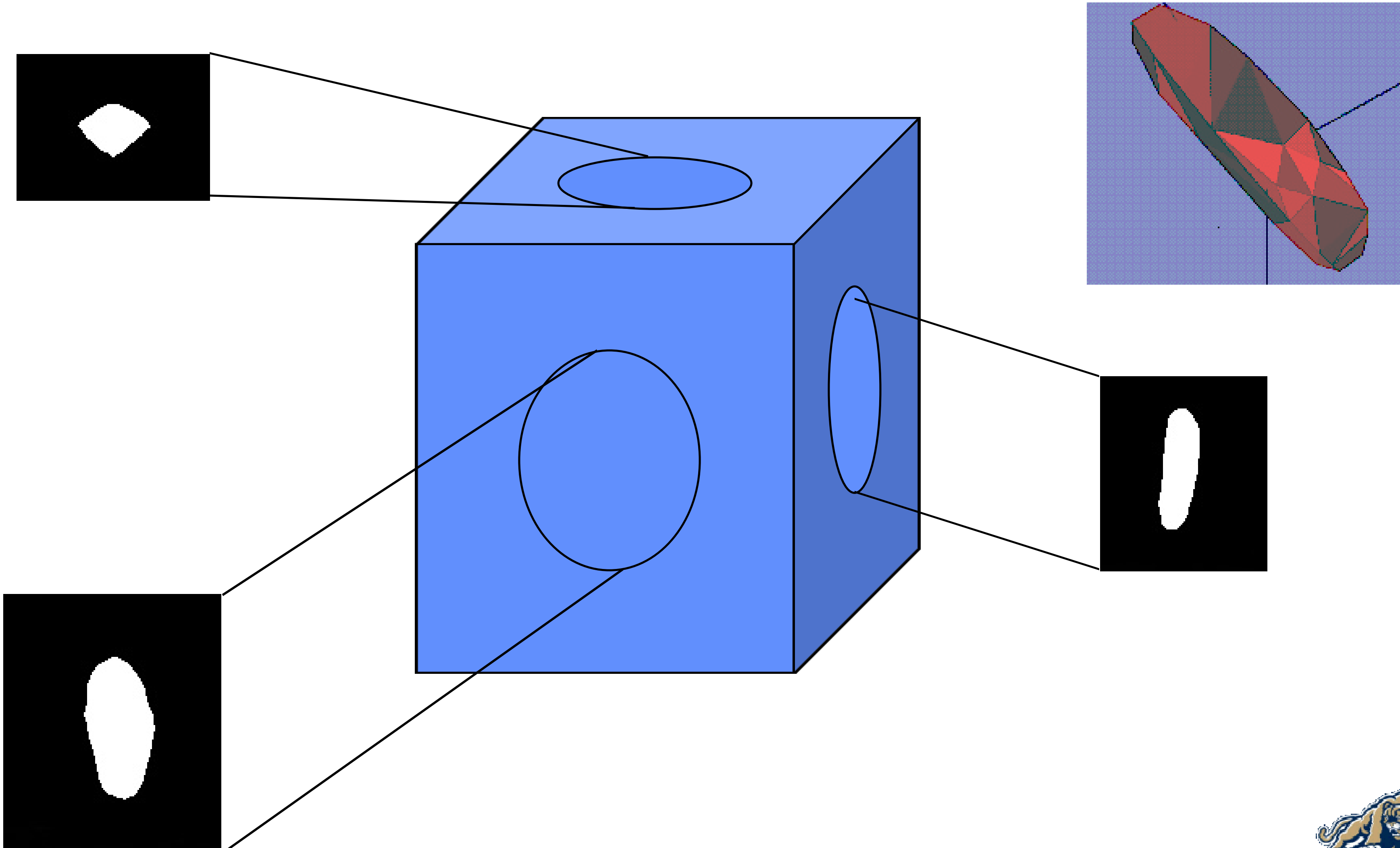
Recent work indicates all issues are resolvable, but there are poor combinations of fuel, boiler, and operation.

Carbon Burnout

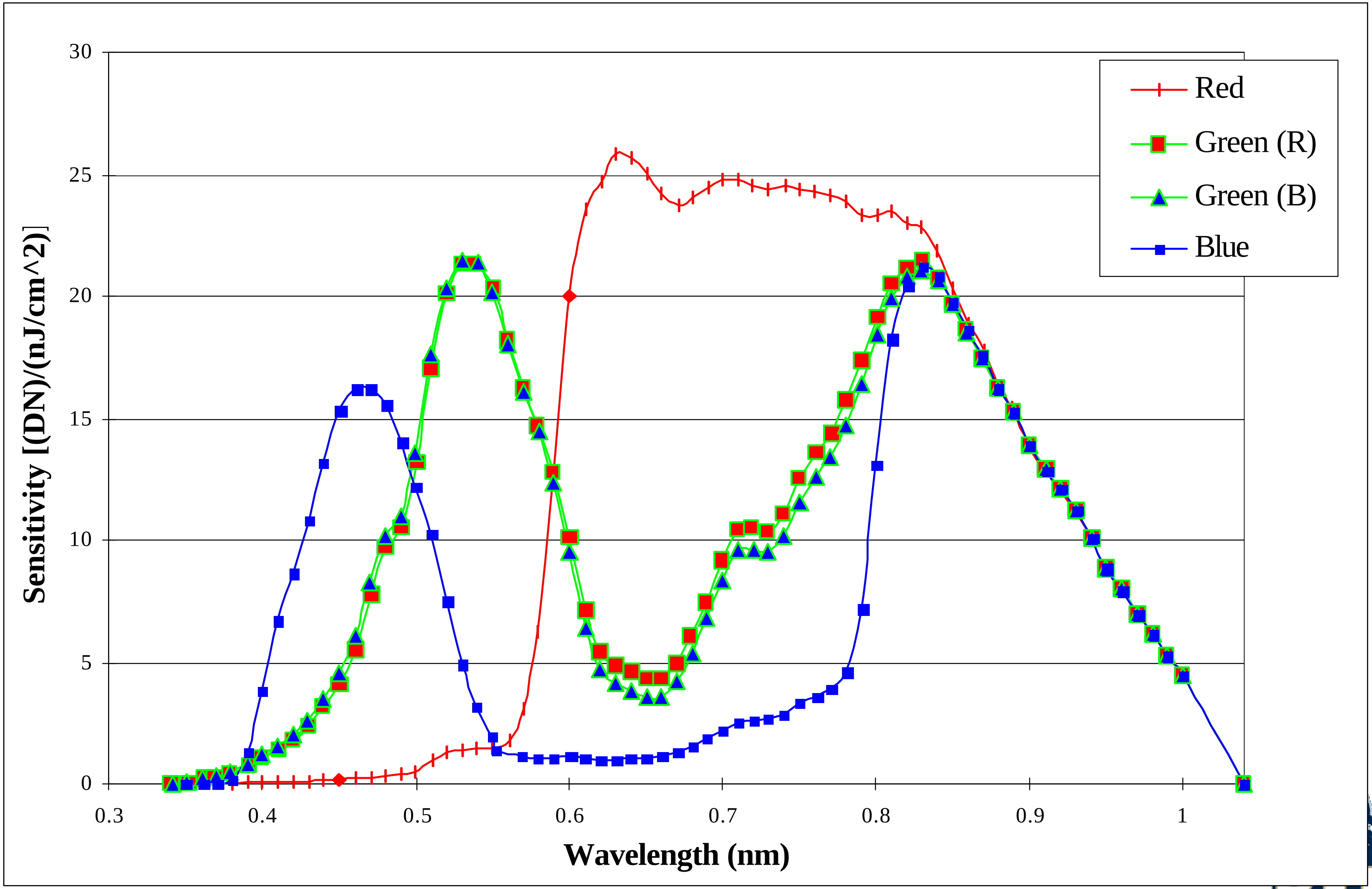
Pulverized Coal Particle
~ 100 μm

Biomass Particle
1 mm x 3 mm +

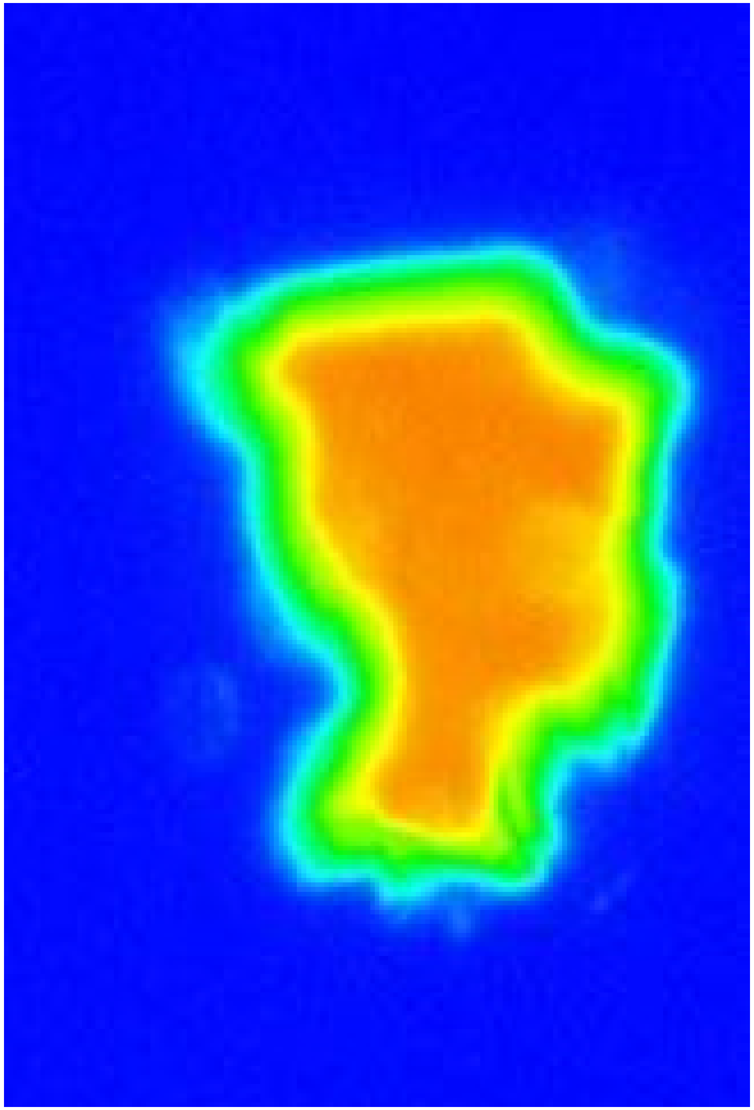
3-D Particle Recreation

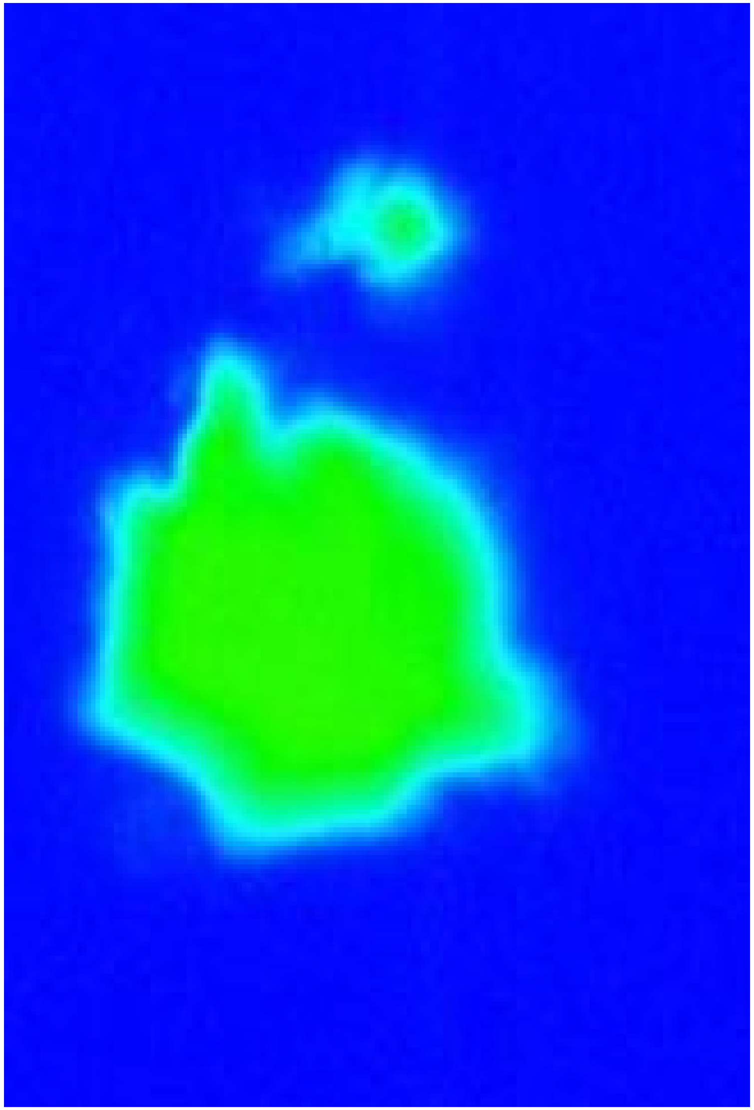


Spectral Analysis of Image

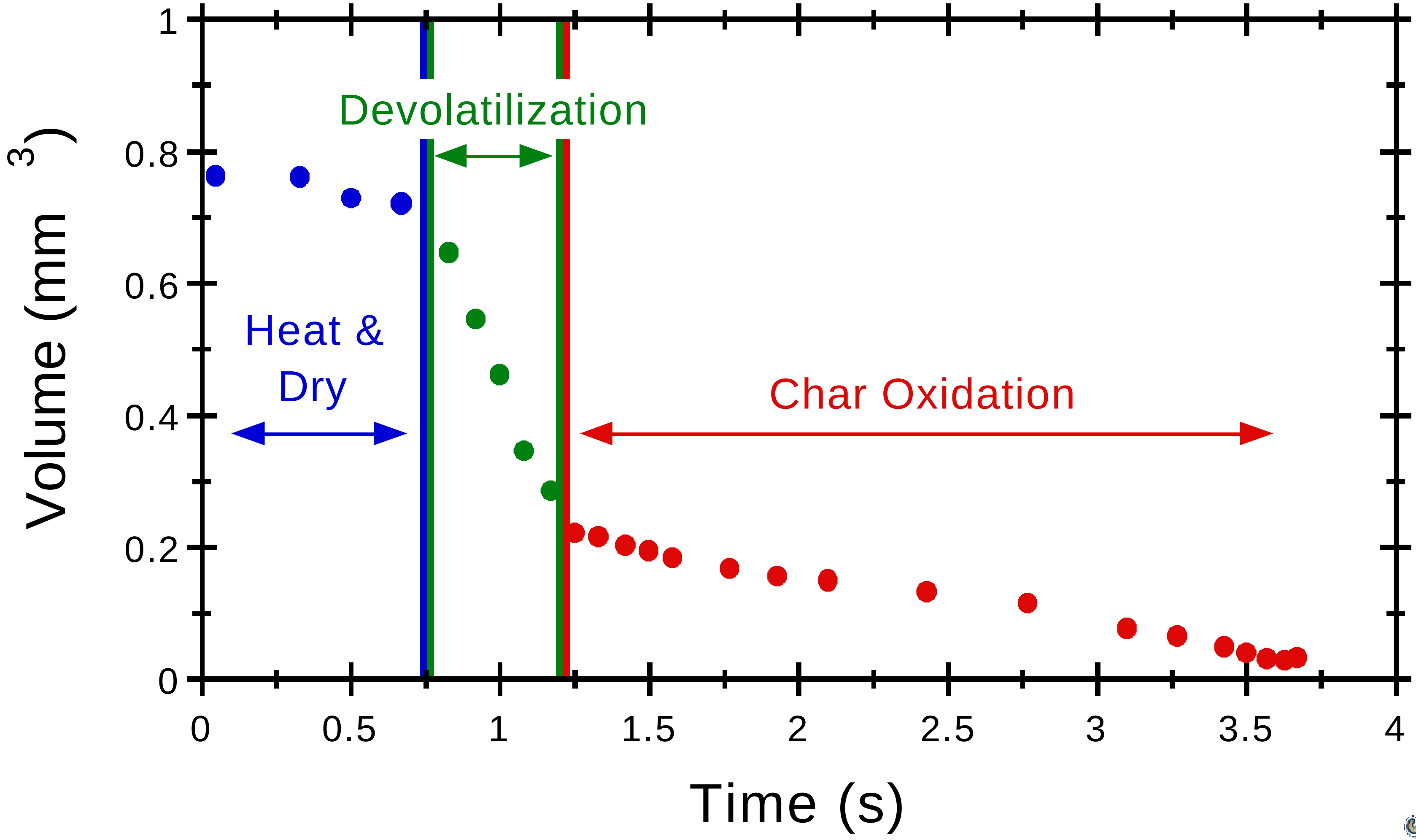


Temperature Profiles





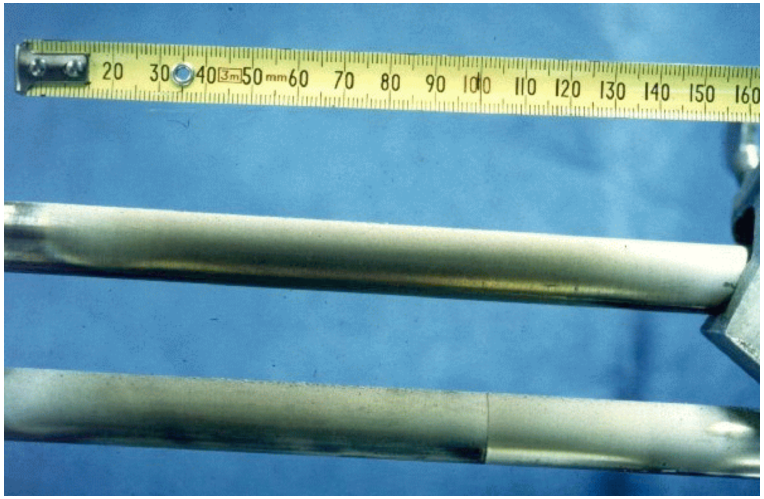
Combustion History: Switchgrass



Cofiring Deposition

1

3



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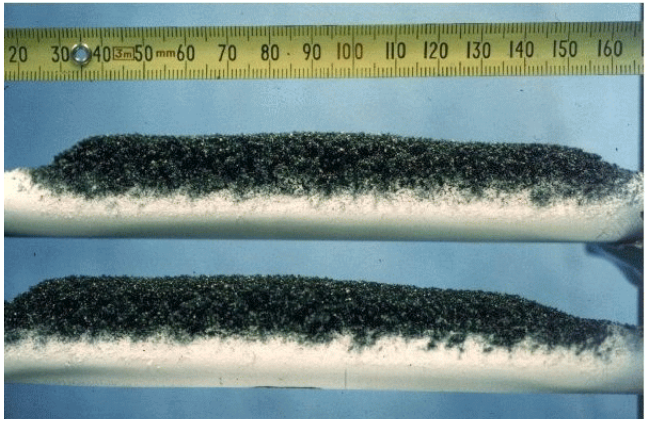

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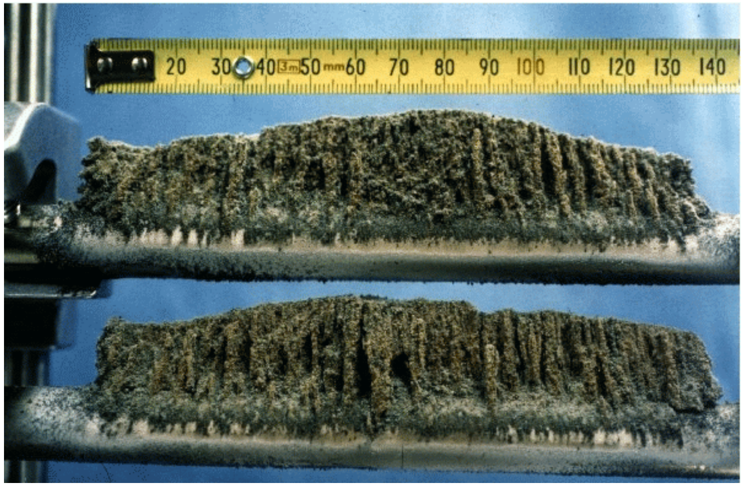
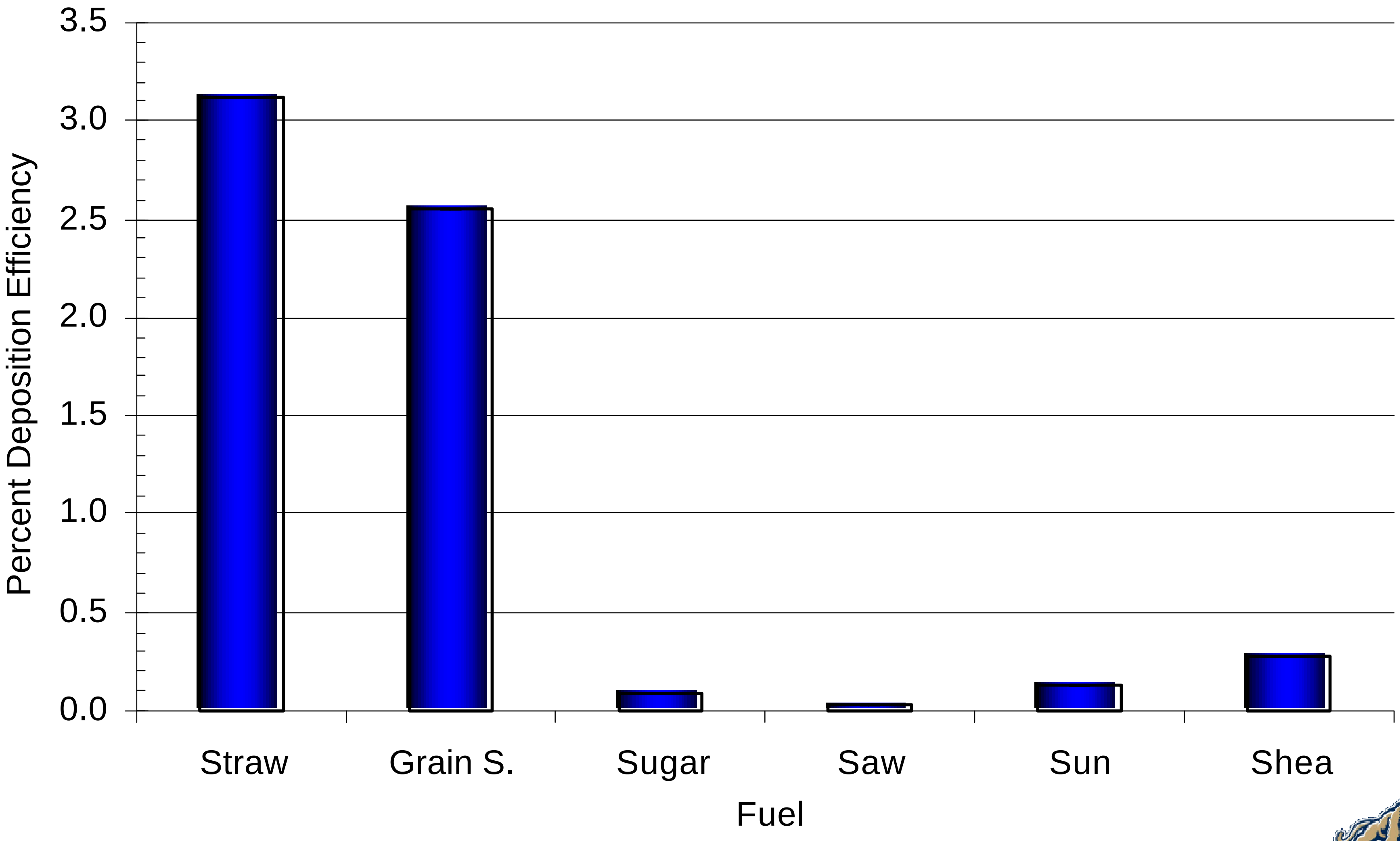
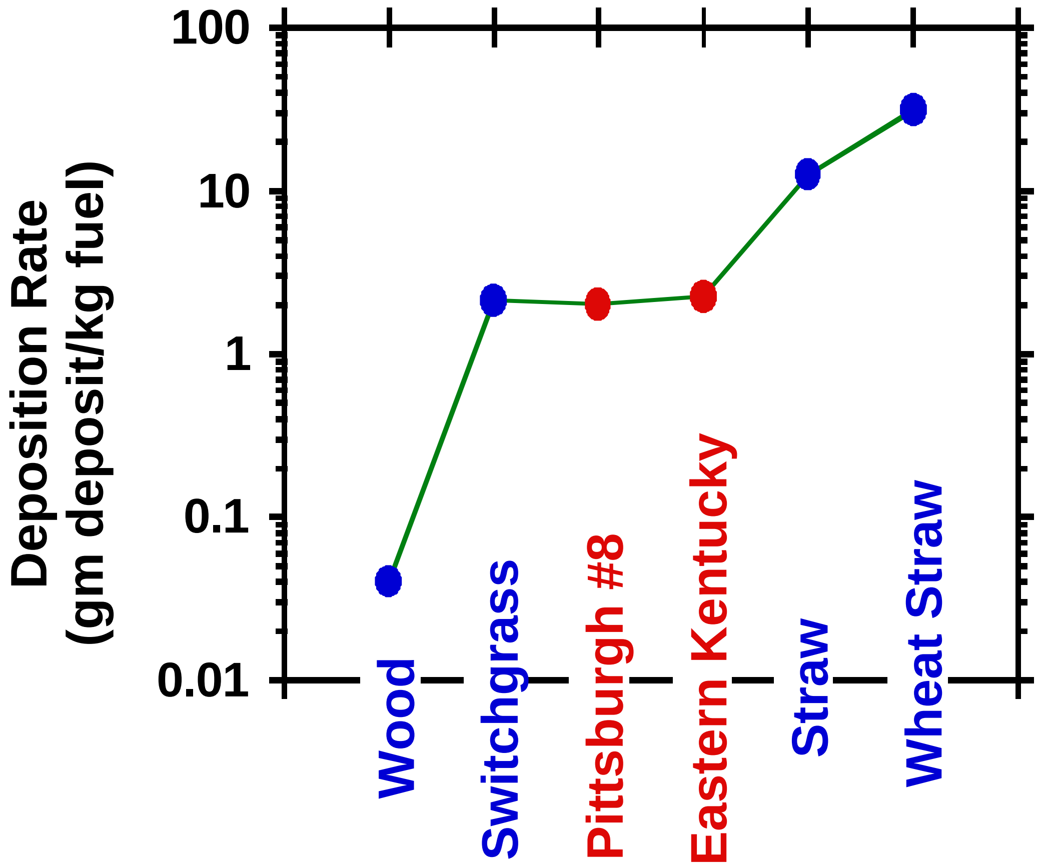


Large Difference in Deposit Behavior

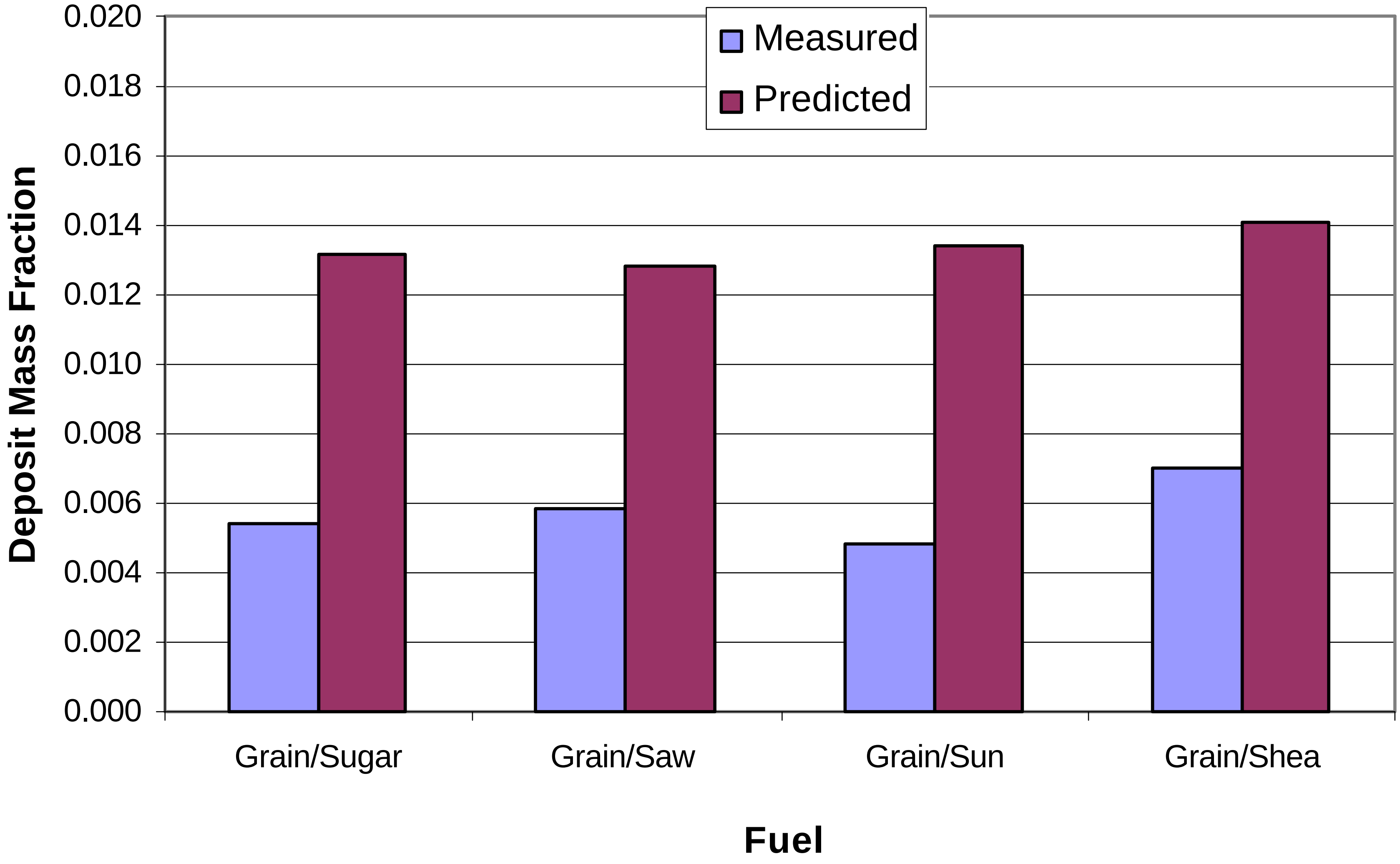


Deposition Rates Vary Widely

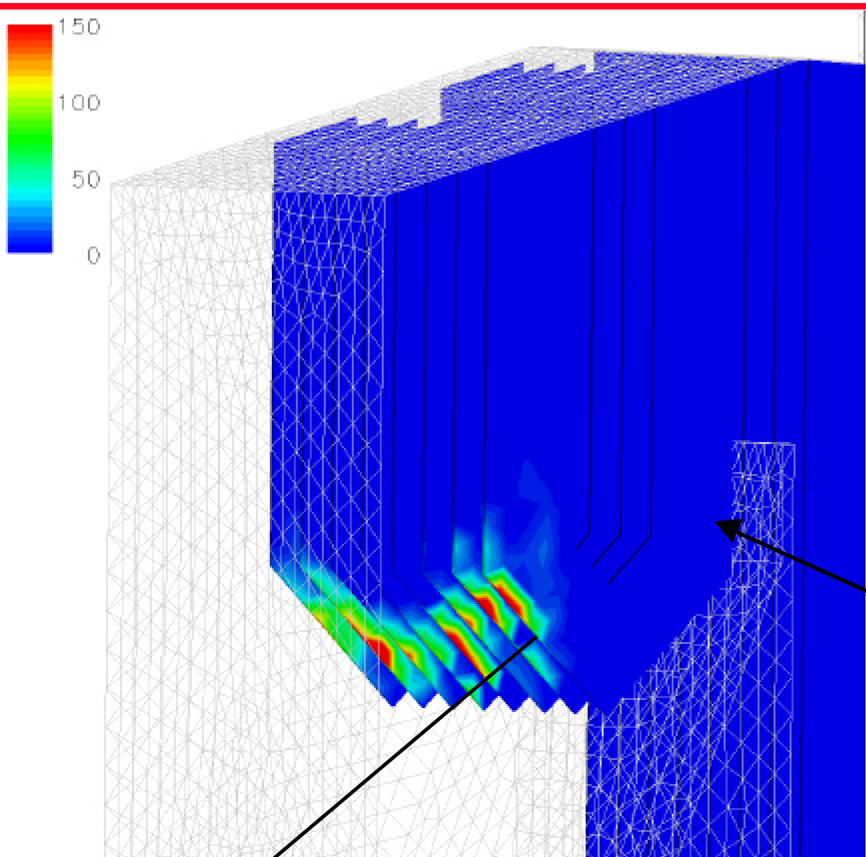
- **Cofiring biomass can lead to either decrease or increase in deposition rates.**
- **Cofiring decreases deposition relative to neat fuels.**

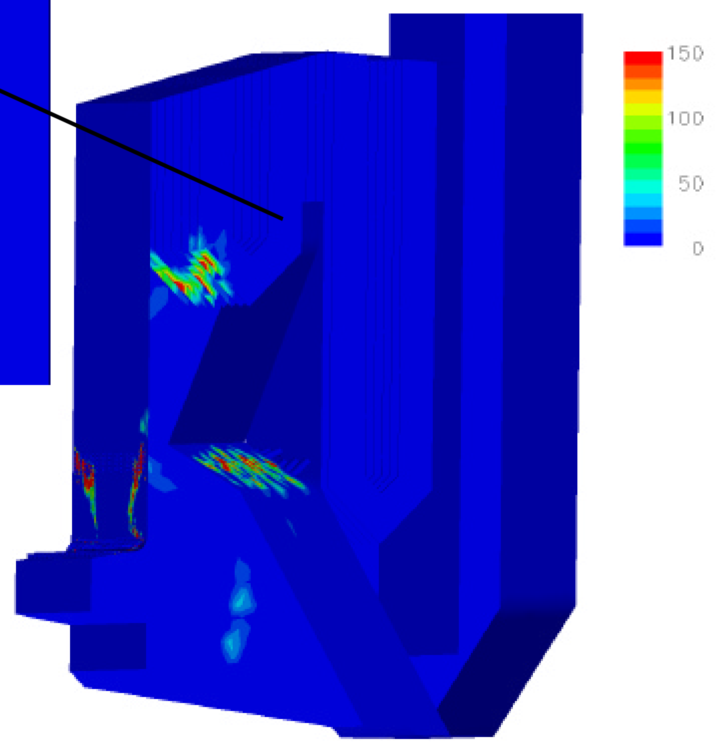


Interactions Are Significant

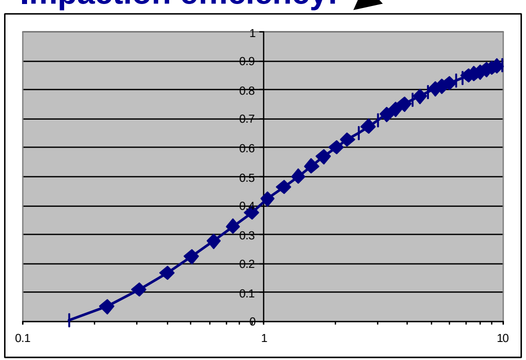


Inertial impaction (clean surface)



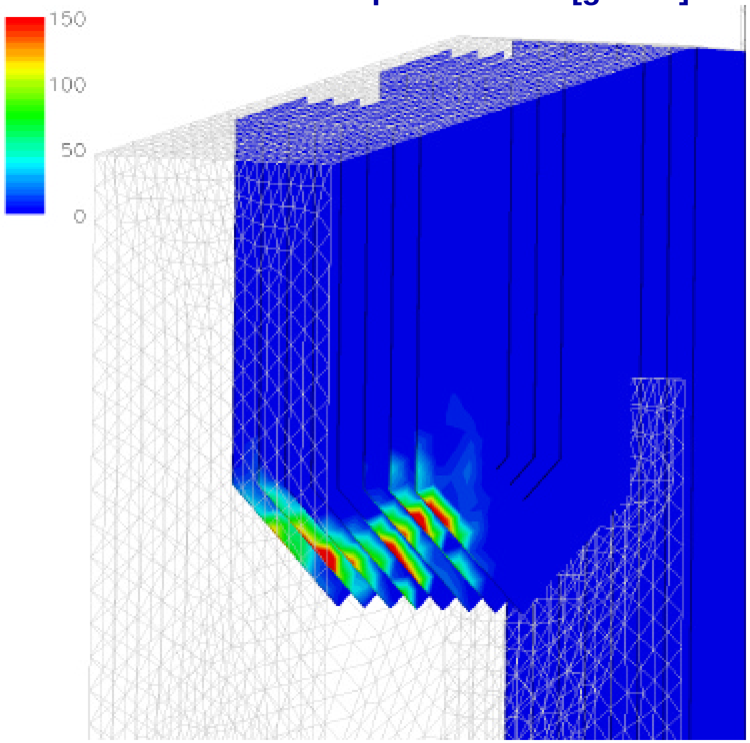


Impaction efficiency:

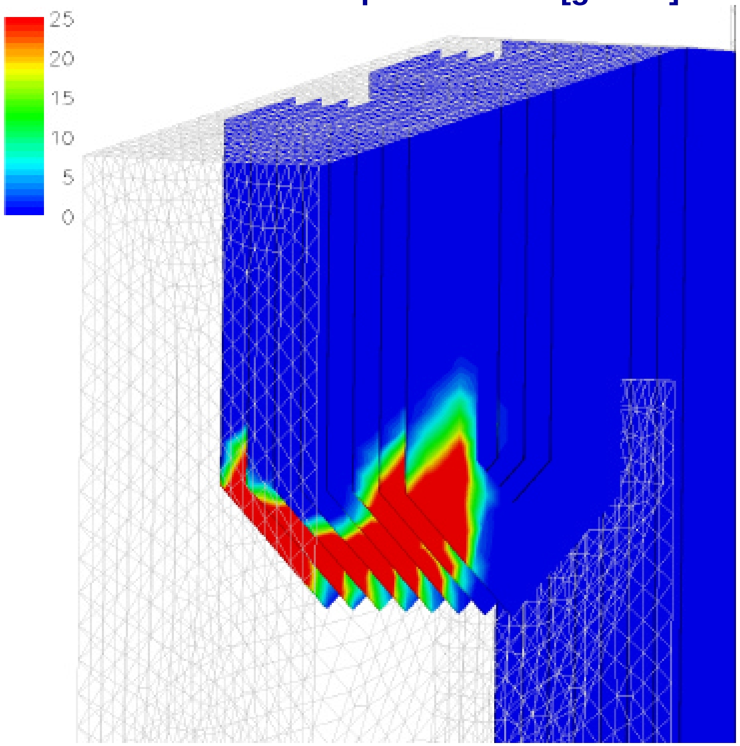


BL mechanisms

Inertial deposition flux [g/m²/h]

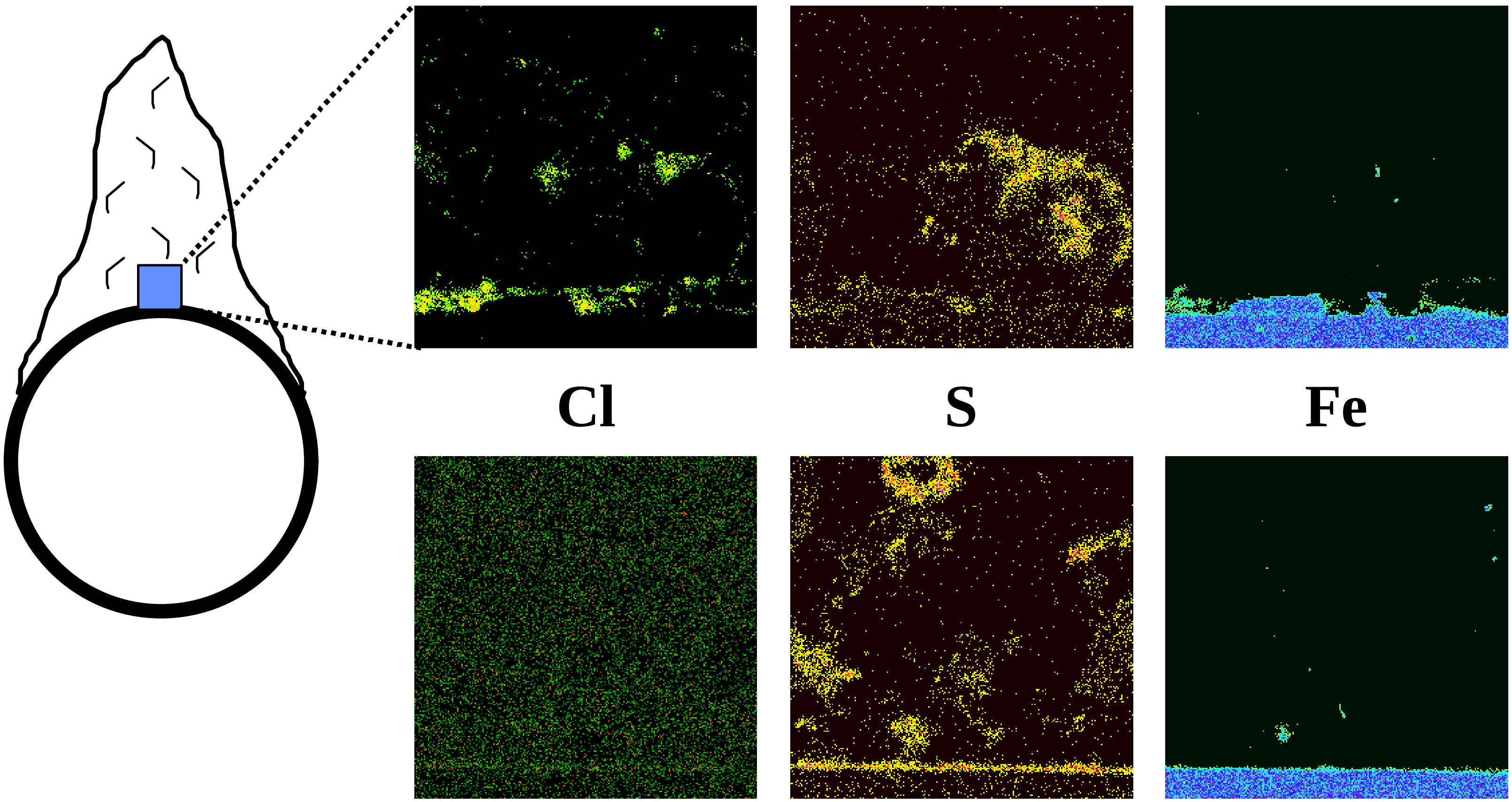


BL deposition flux [g/m²/h]



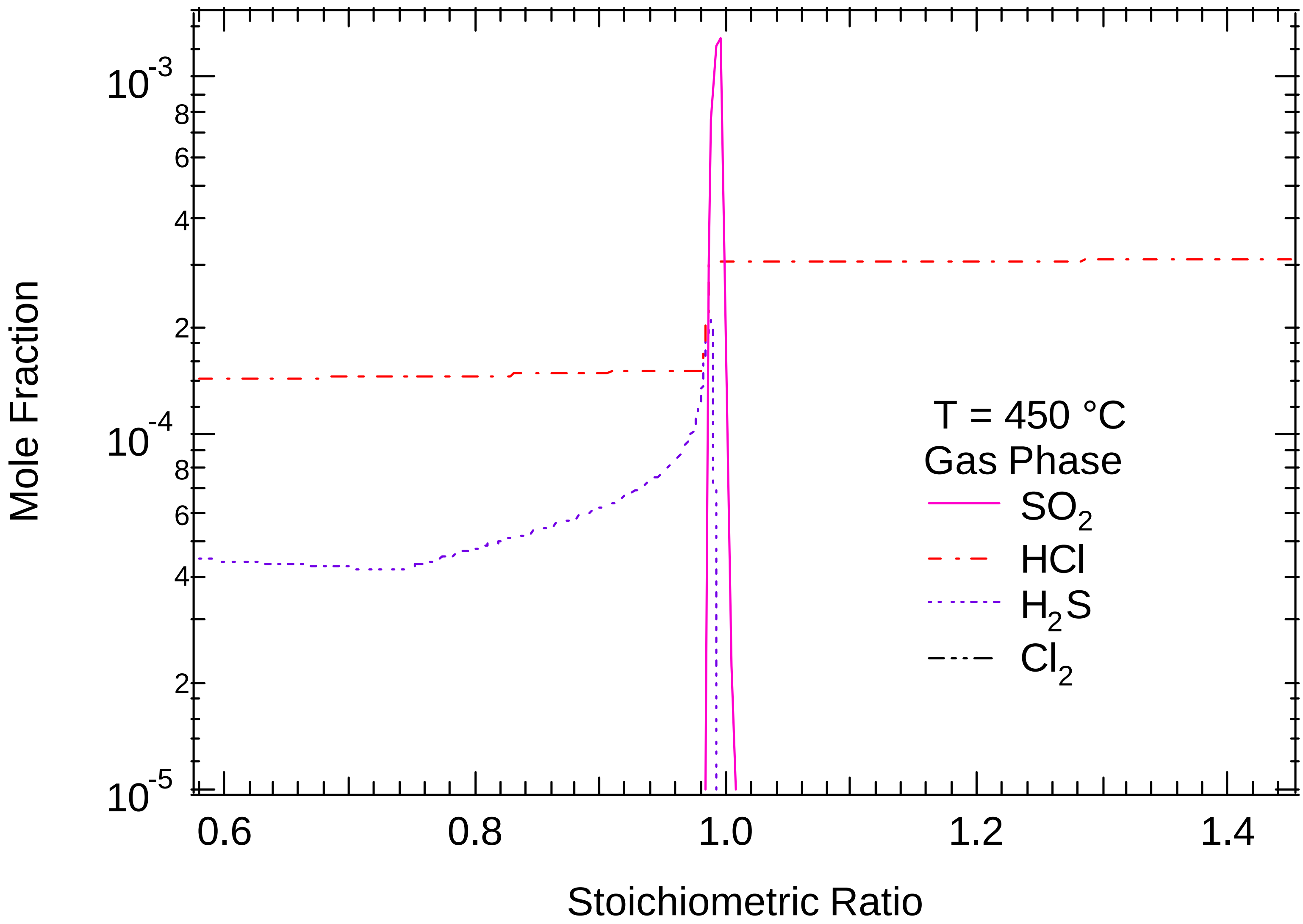
Cofiring Mitigates Corrosion

100% Imperial Wheat Straw

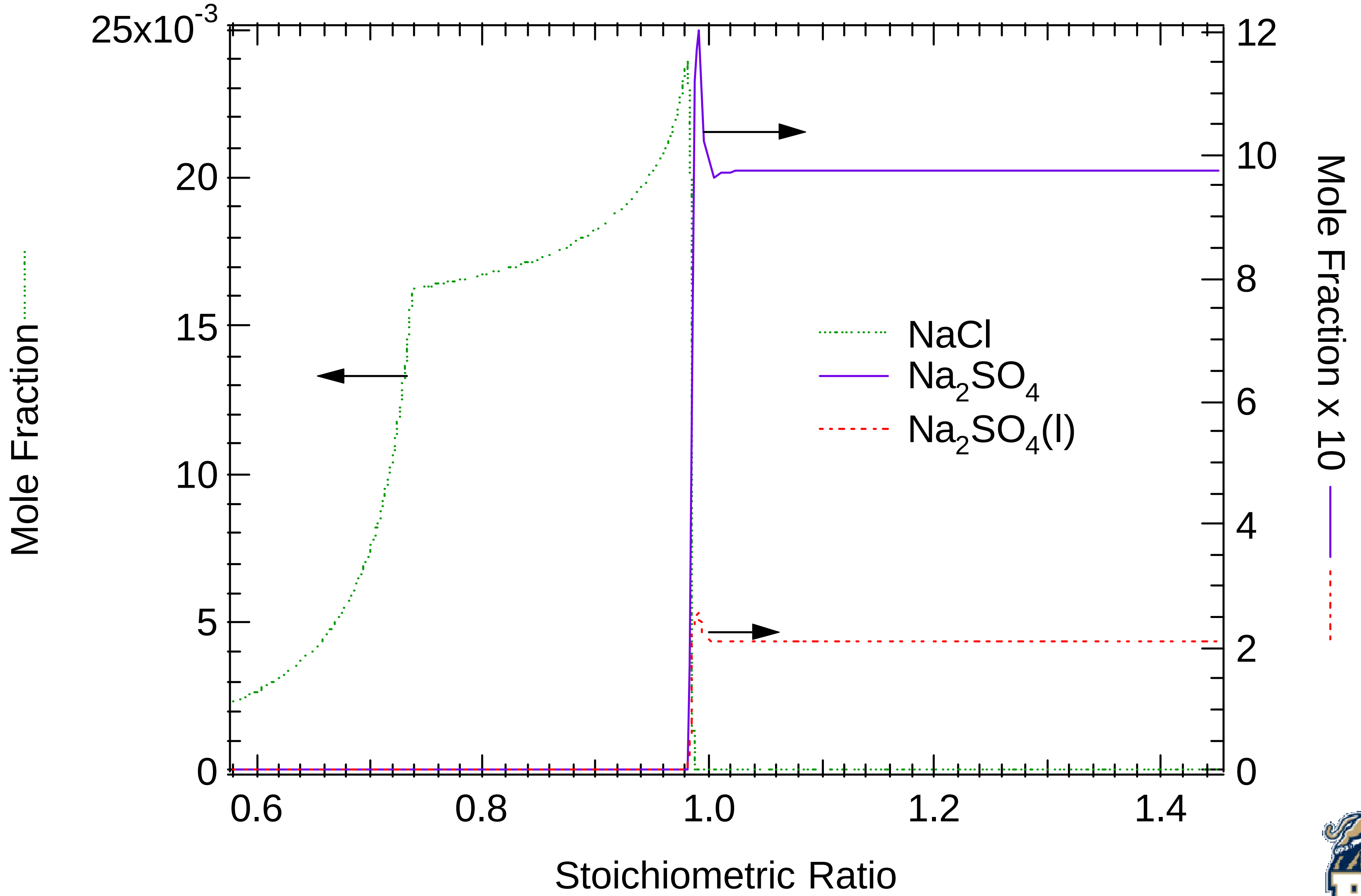


85% E. Kentucky 15% Wheat Straw

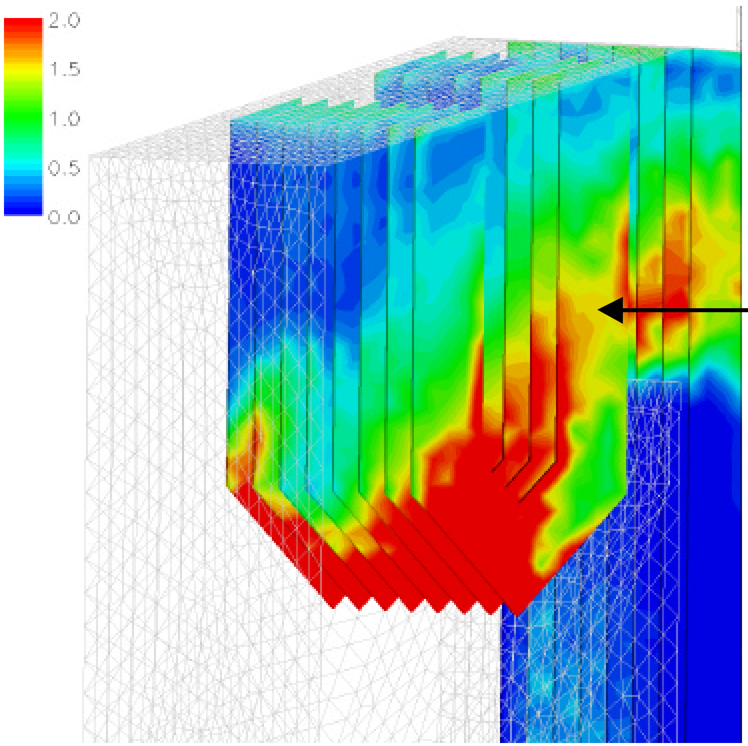
Chlorine Forms in Gas



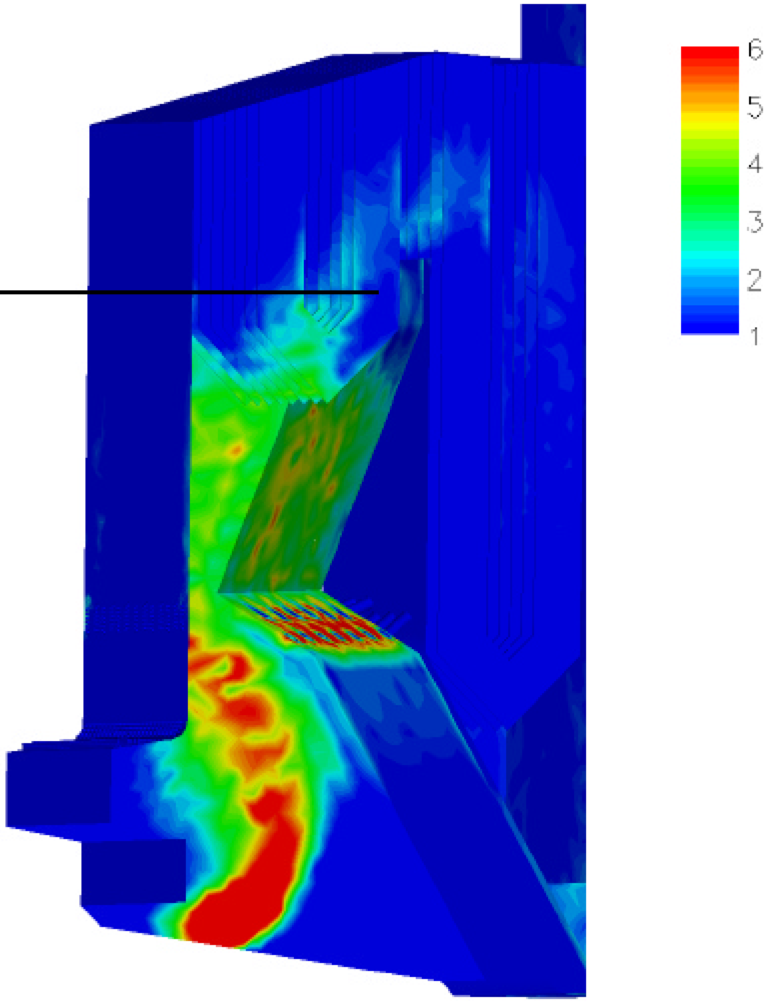
Oxidizing Conditions Favor Sulfates



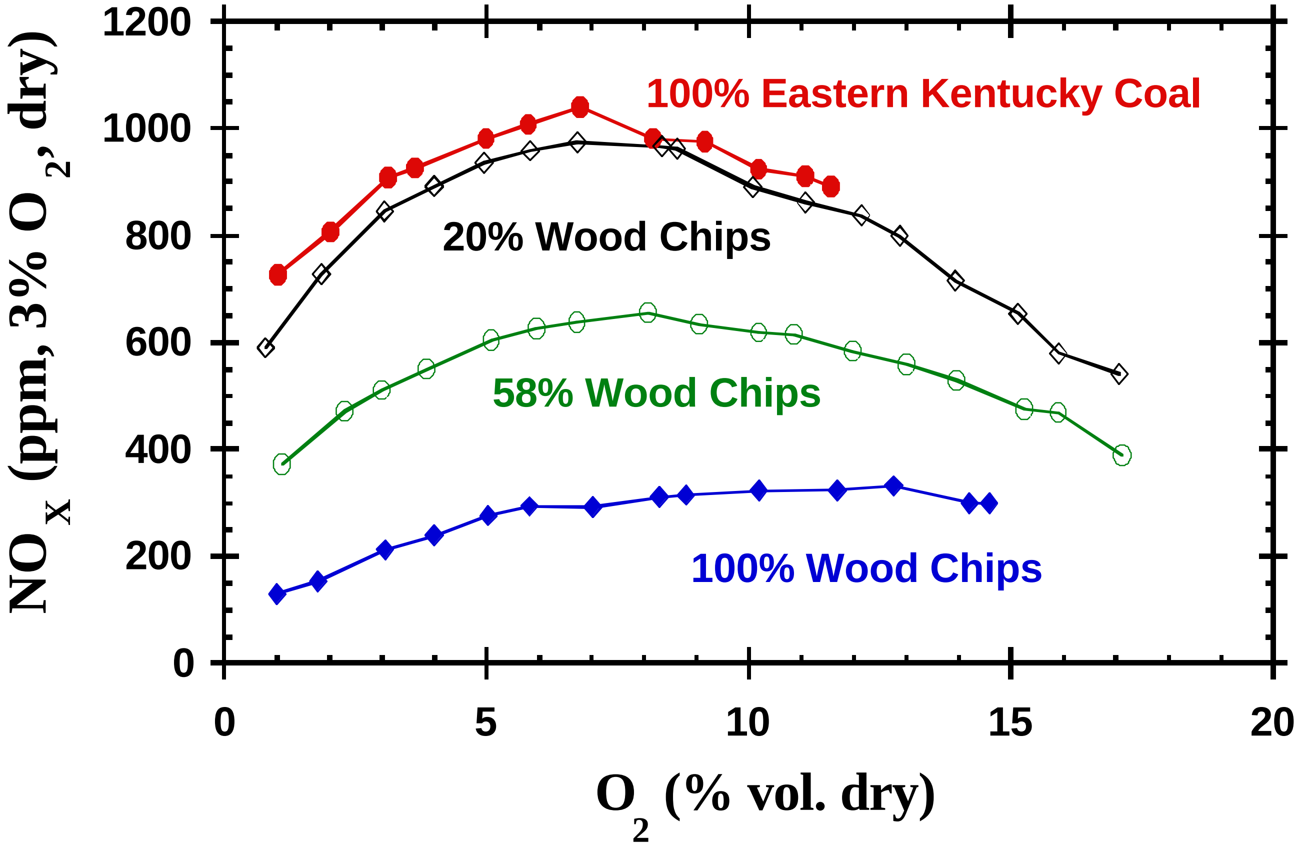
Vapor deposition



Vapor deposition flux [g/m²/h]

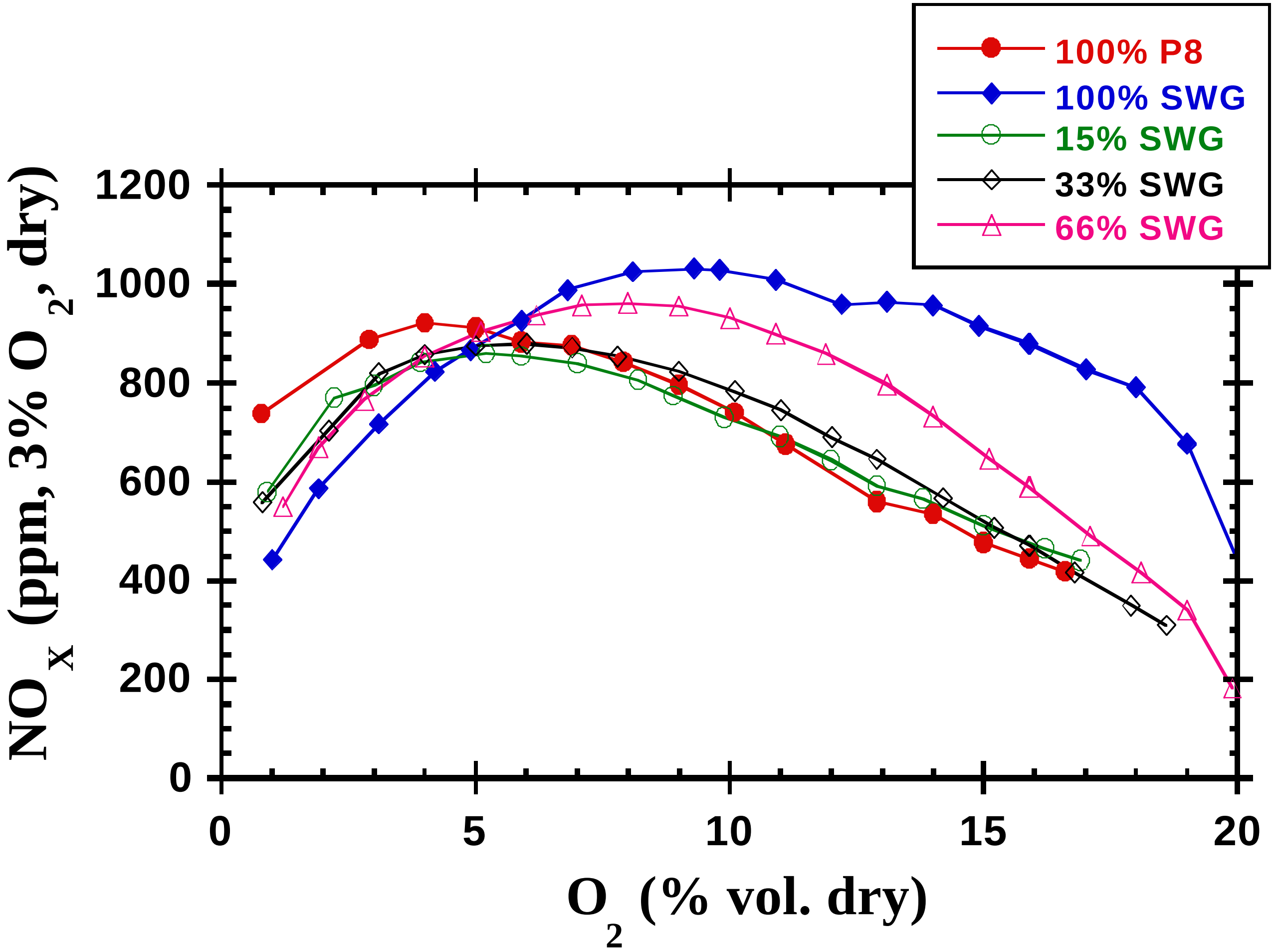


NO_x Emissions During Cofiring



Fuel Nitrogen (lb N / MMBtu)	
Coal	1.2
Wood	0.18

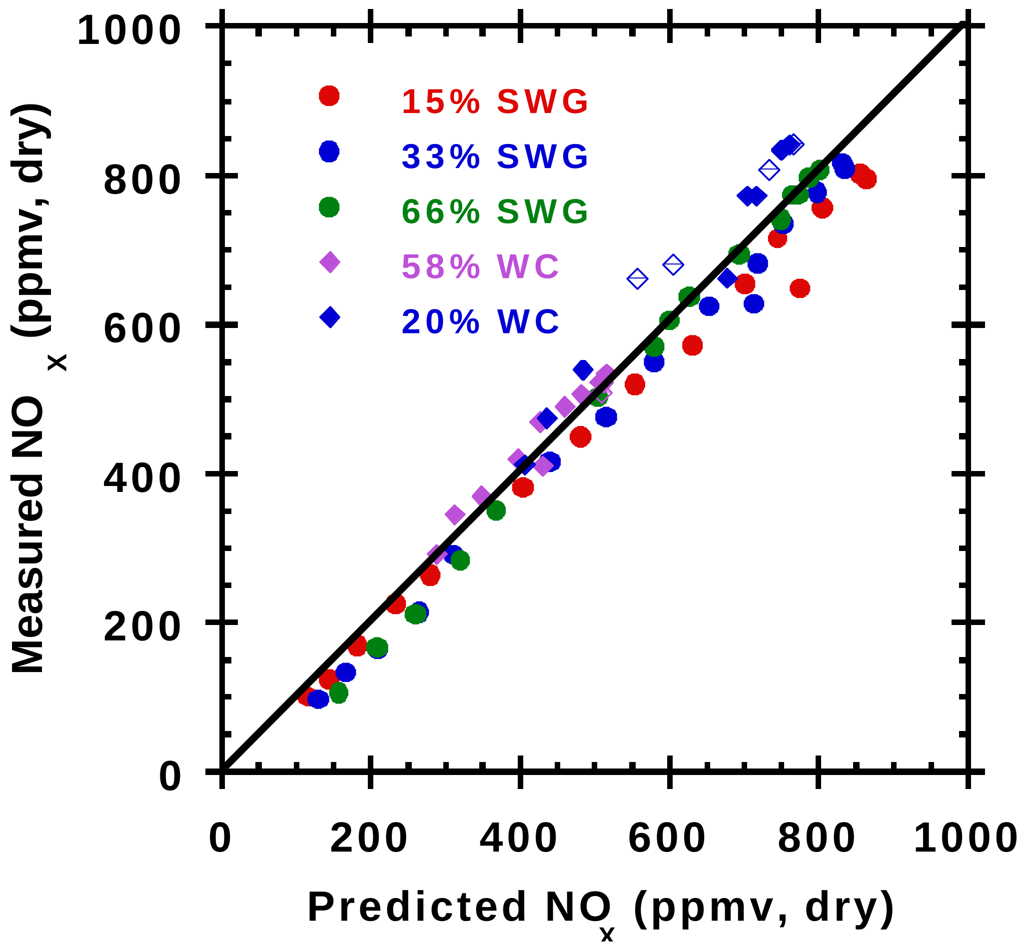
NO_x Emissions During Cofiring



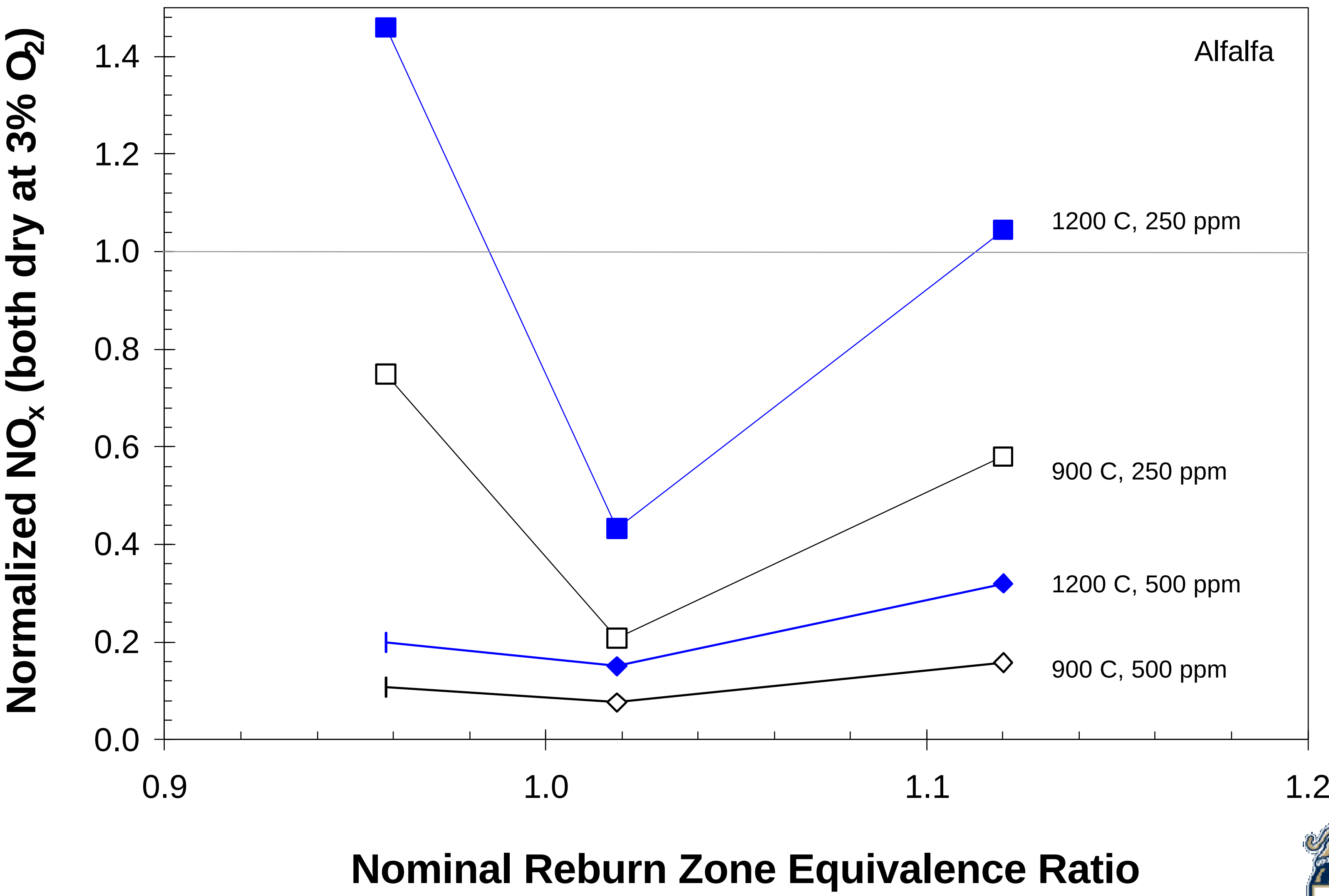
Fuel Nitrogen
(lb N / MMBtu)

Coal	1.0
SWG	0.77

NO_x Emissions



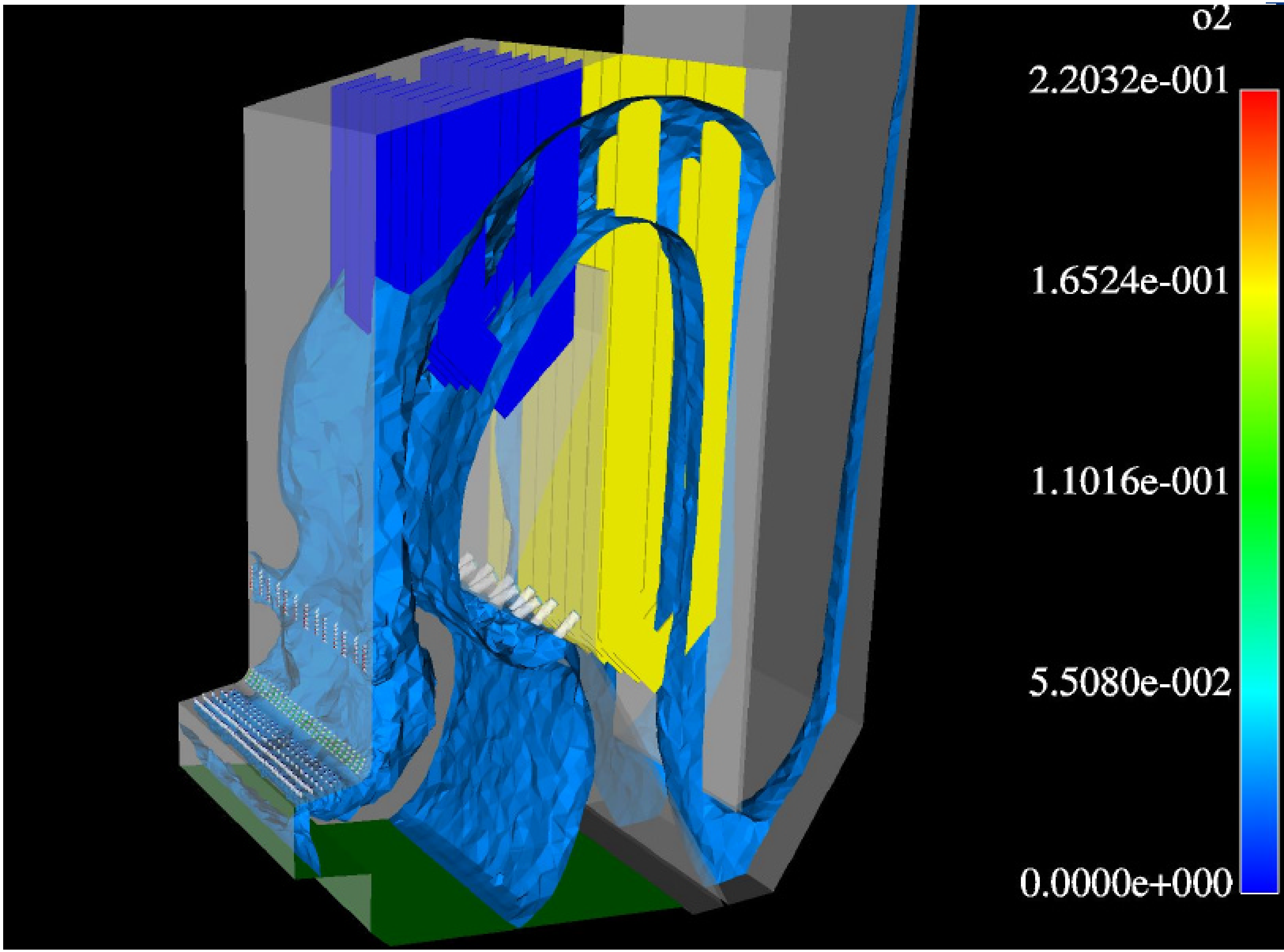
Stoichiometry & Temperature



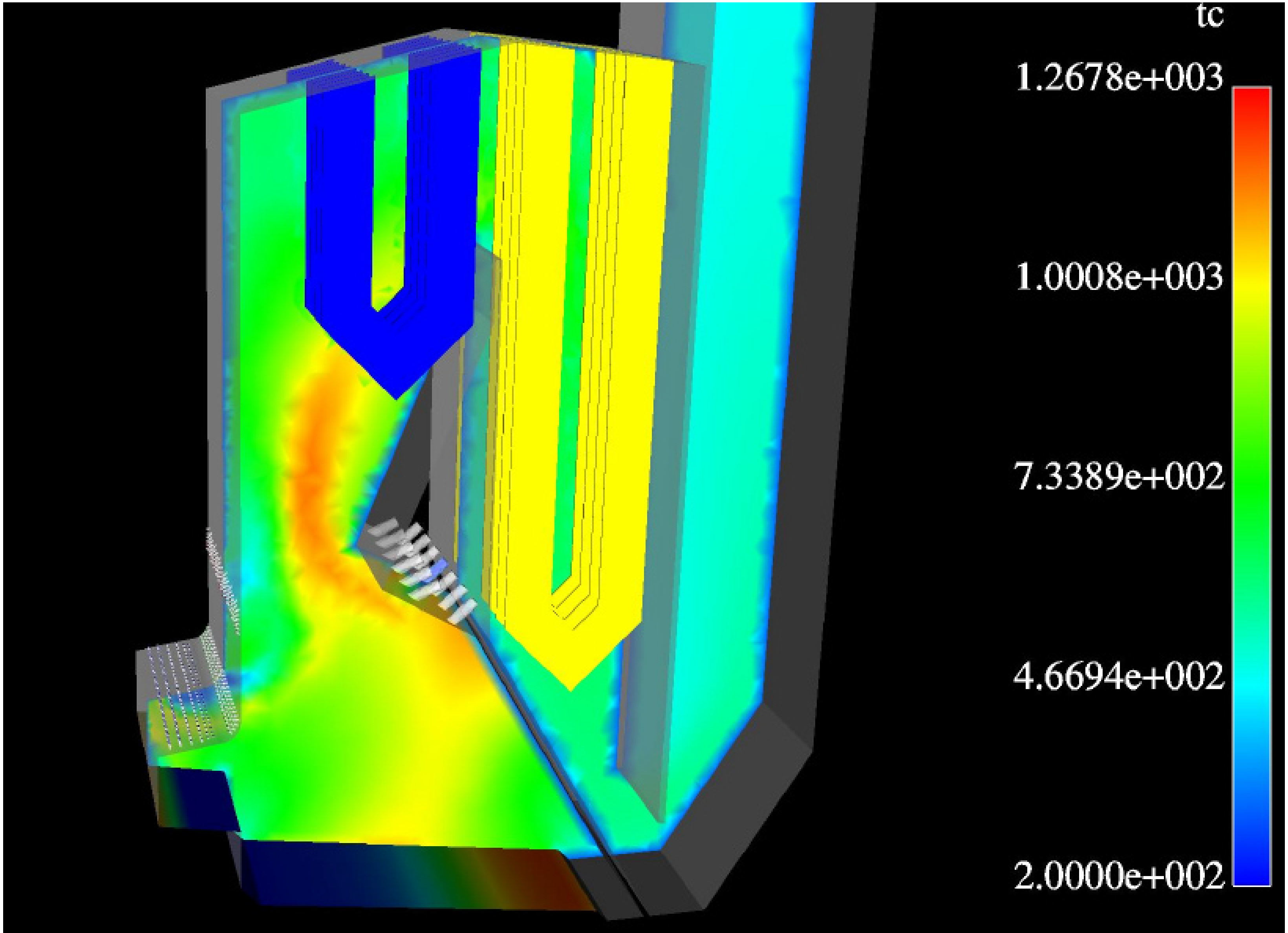
Commercial Gasifier Data

Pollutant	Limit lb/MMbtu	Typical lb/MMbtu	Control
Particulate	0.352	0.04	ESP
Opacity	20%	2%	Monitor
SO_2	0.25	0.03	Limestone in bed
NO_x	0.48	0.48	Fuel
CO	0.48	0.06	Burner

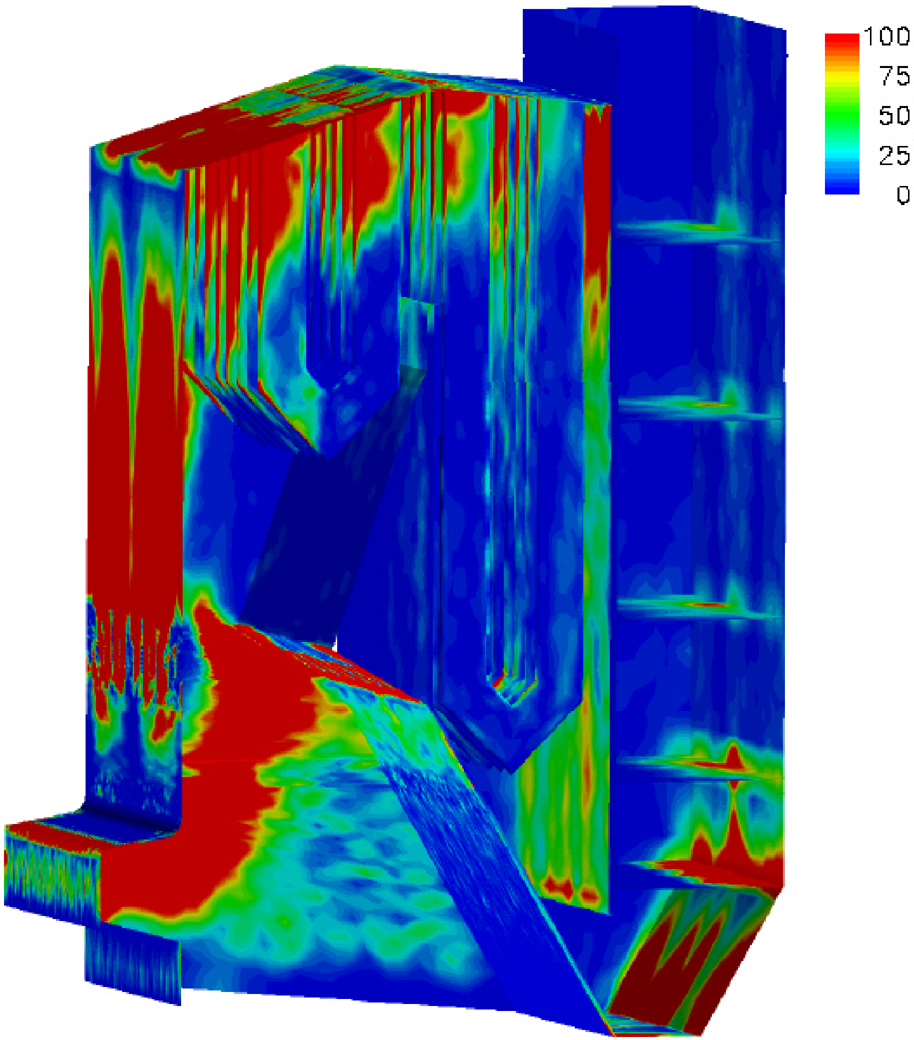
Oxygen Isosurfaces



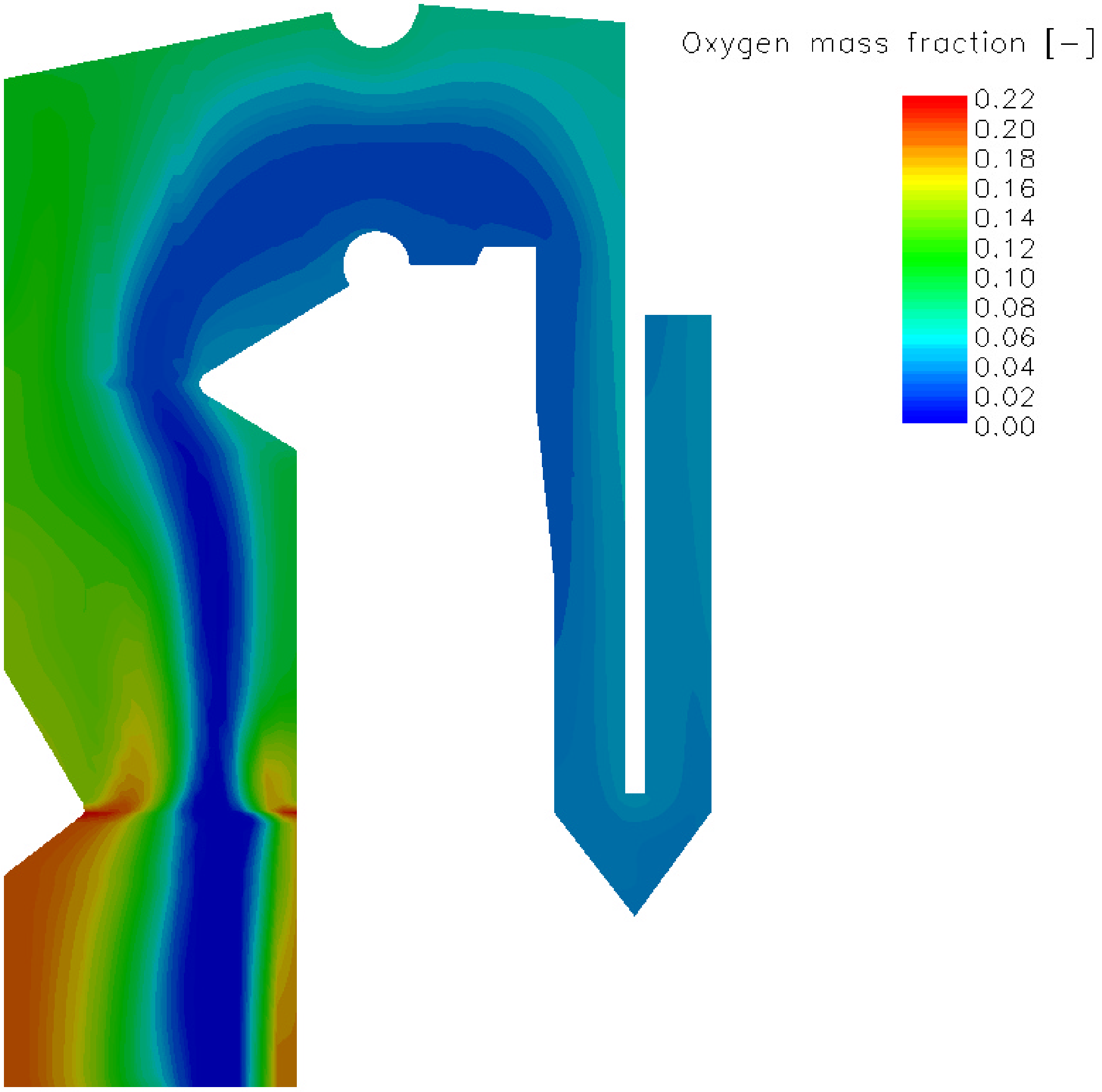
Temperature Variations



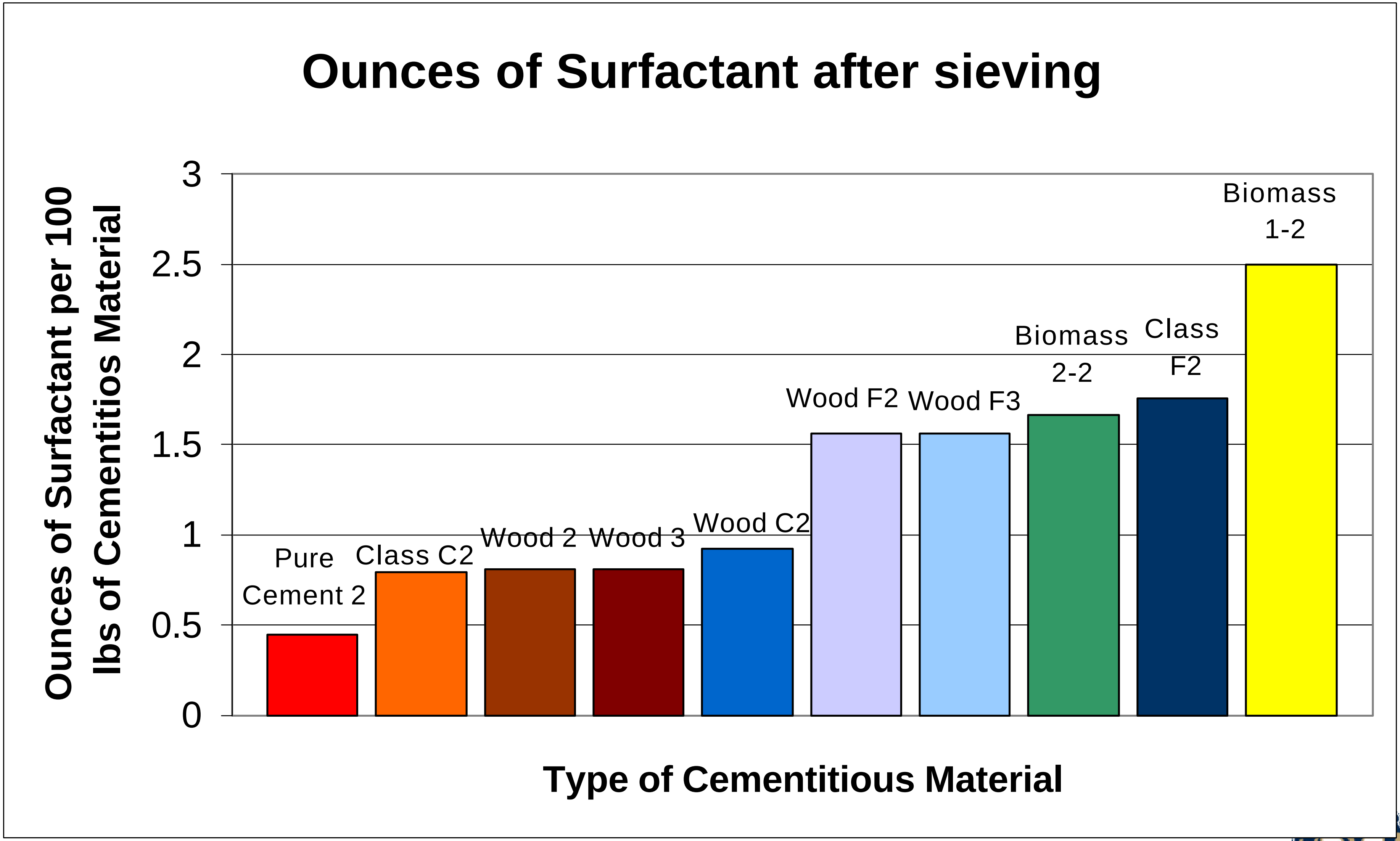
Temporal Deposition Variation



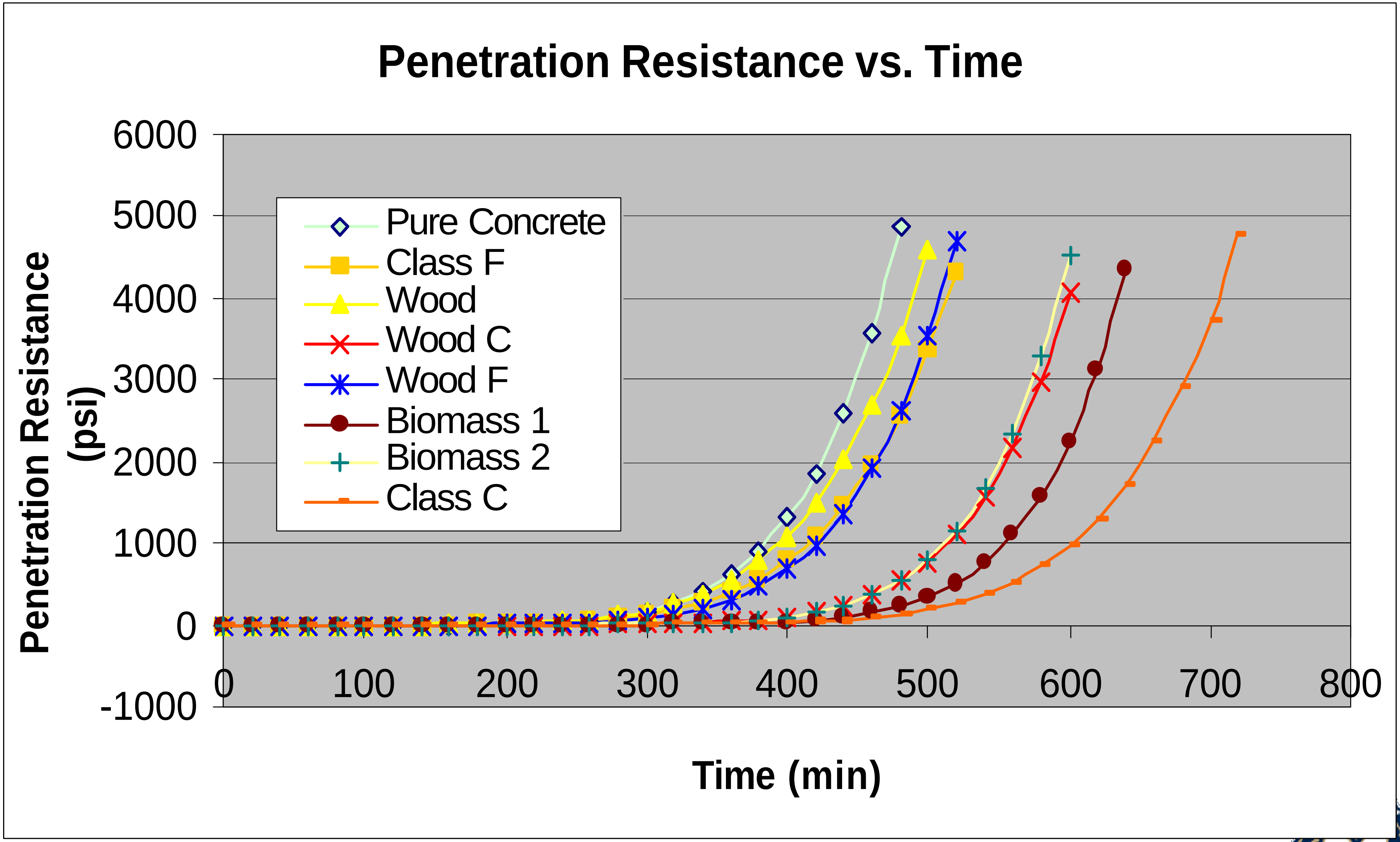
Oxygen Contours



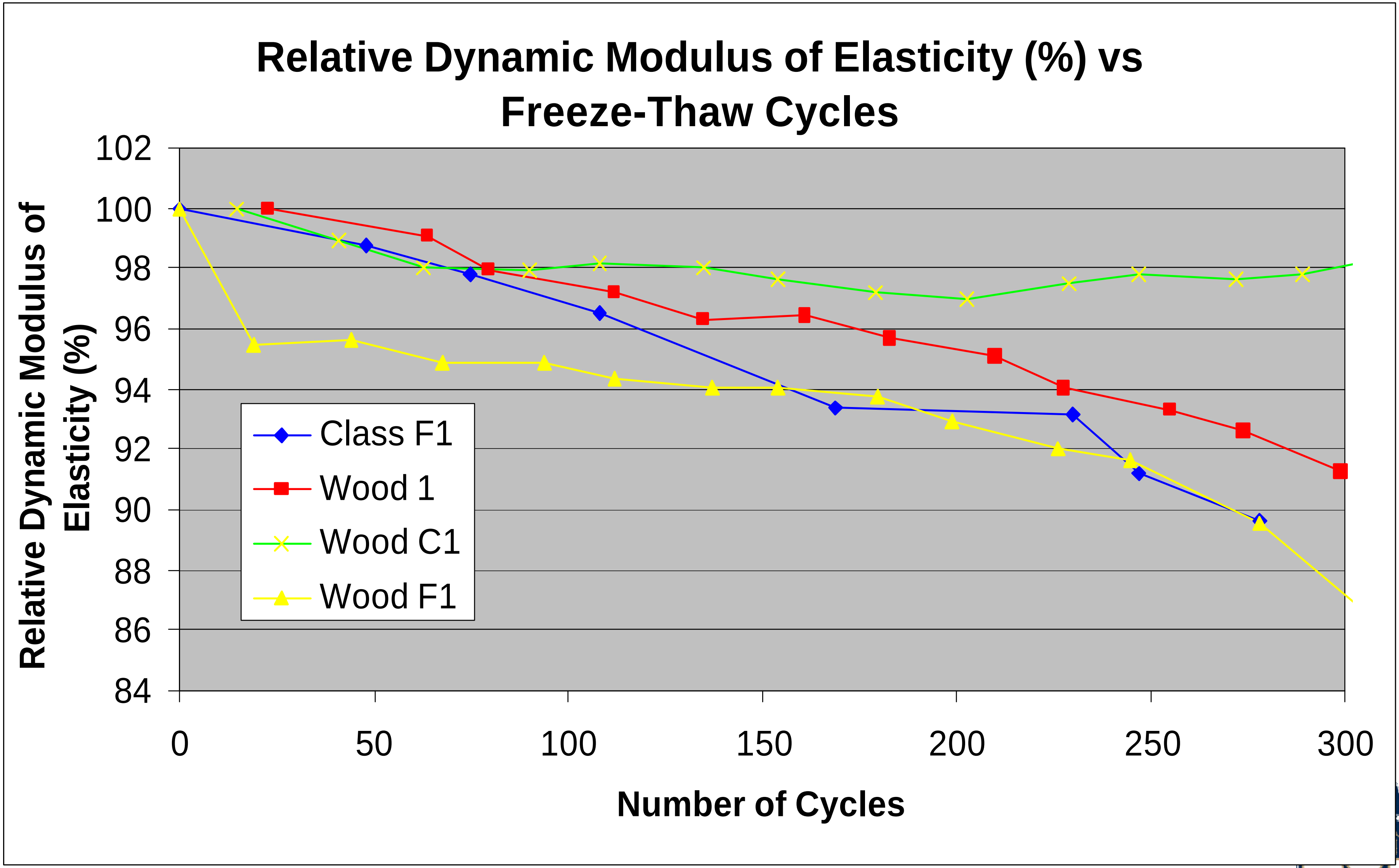
Required Aerating Agent



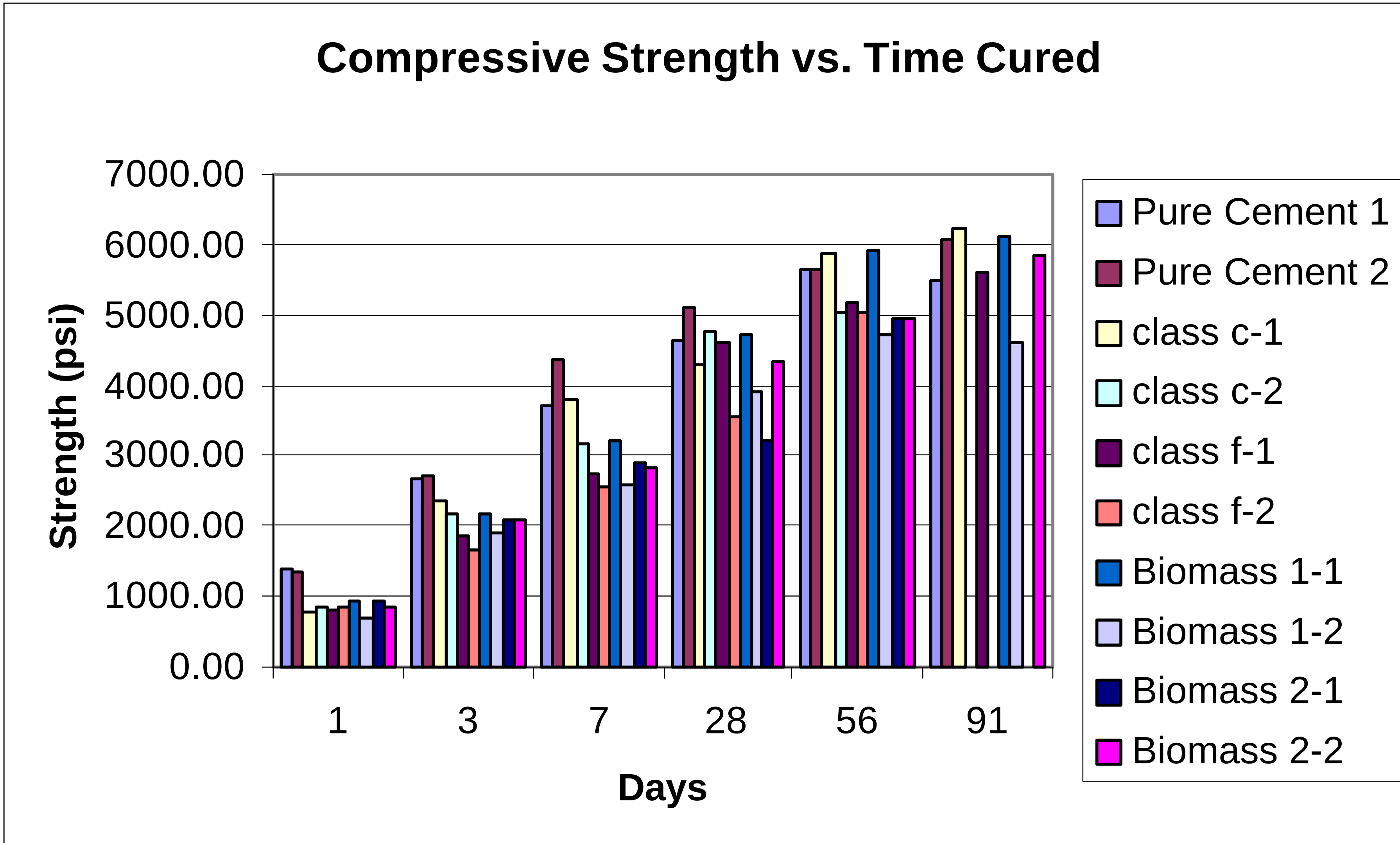
Set Time Delayed by Fly Ash



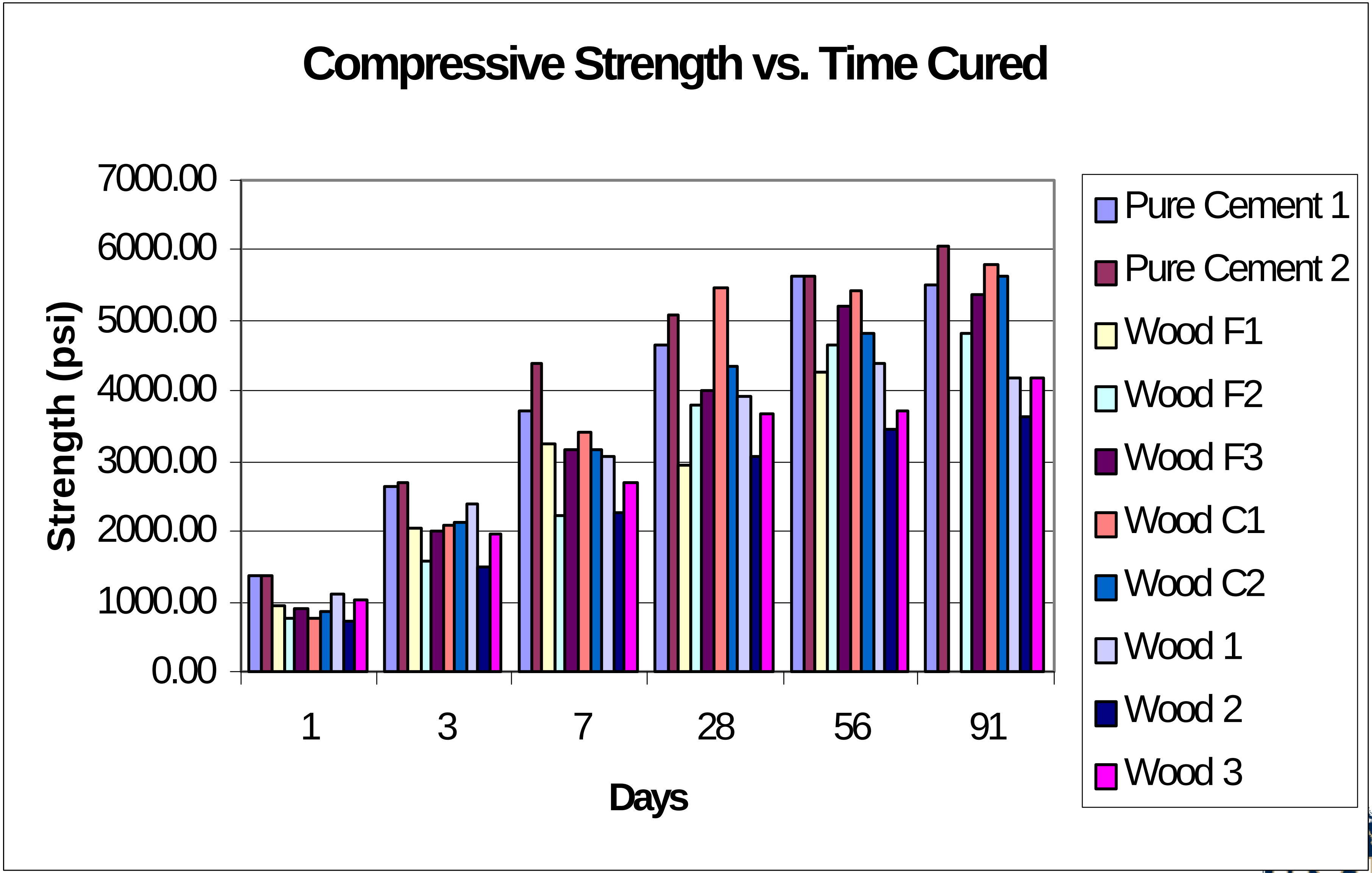
Freeze-Thaw Behavior Adequate



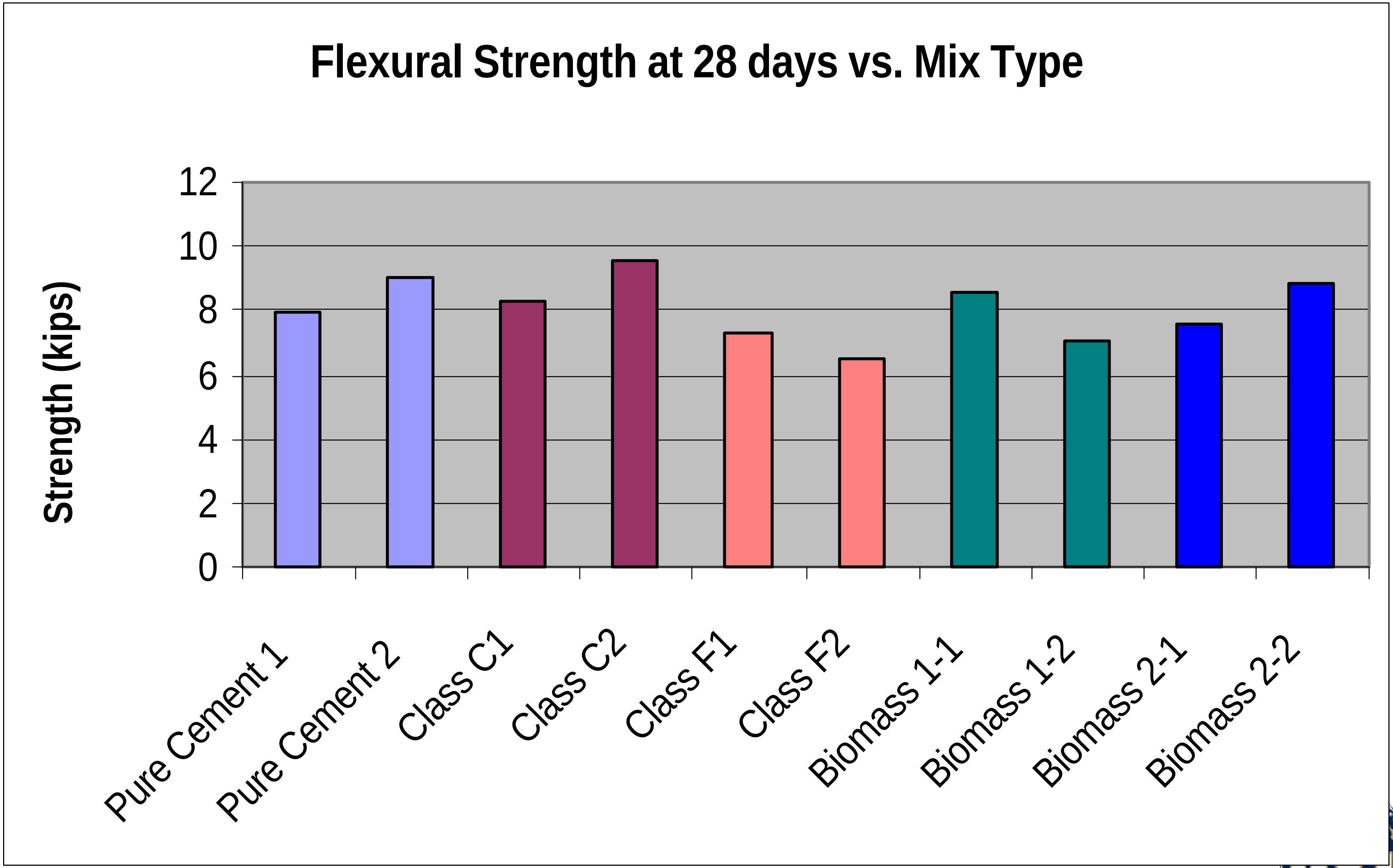
Early Strength Losses Wane



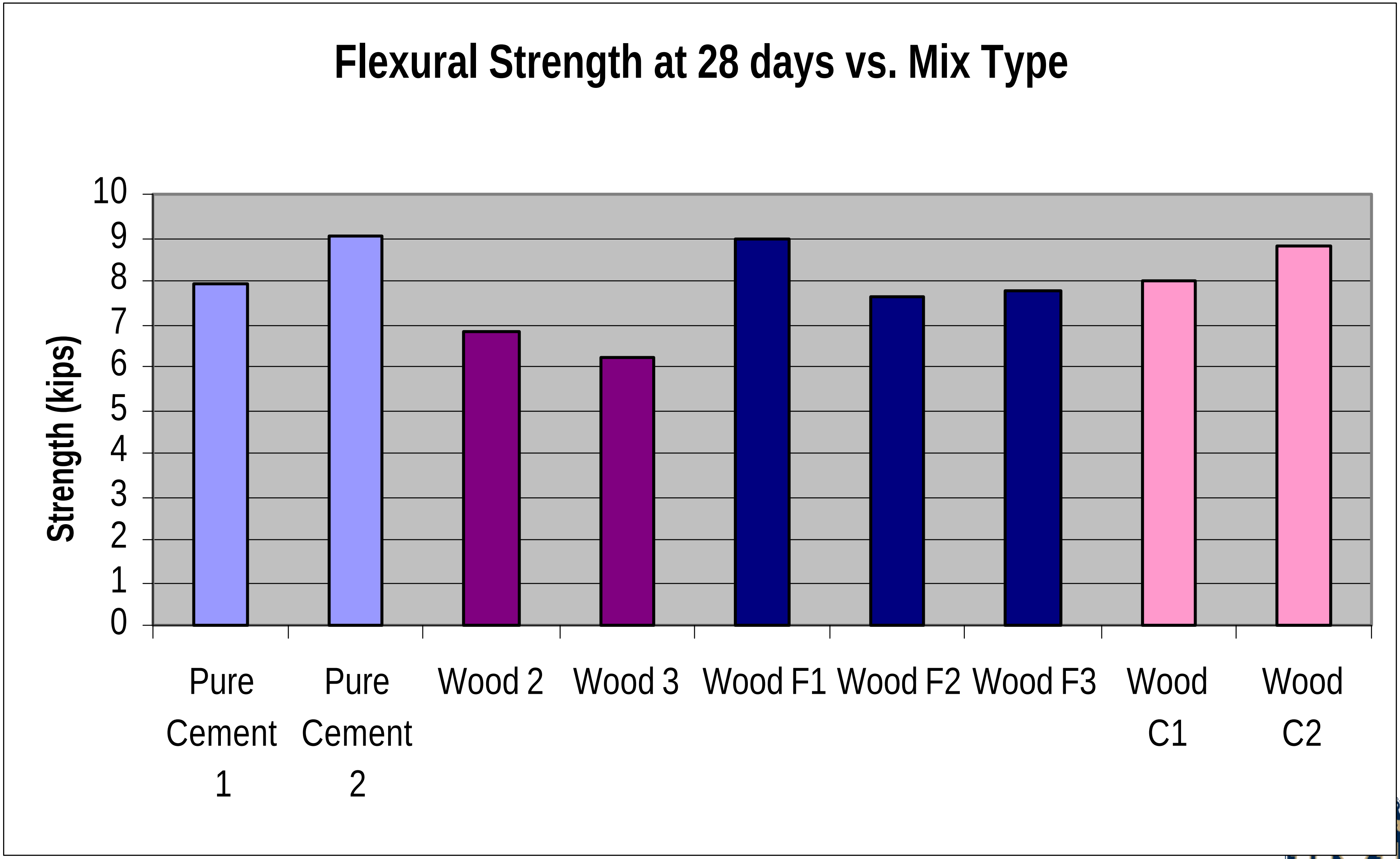
Pure Biomass Fly Ash Deleterious



Minimal Flexural Strength Impact



Possible Flexural Strength Impact



Conclusions

- Major fire-side issues with biomass cofiring include pollutant emissions and impact on emission treatment systems (esp. NO_x and SCR), deposition and corrosion, fly ash utilization, carbon burnout, reactivity, and related issues.
- Wise choices of fuels, boilers, and operating parameters can avoid deleterious impacts. However, less wise choices can lead to substantial negative impacts.
- Biomass cofiring with coal represents arguably the least expensive, lowest risk, and shortest term option for CO_2 reduction in the power sector with potentially 5-15% net reduction possible.

Acknowledgements

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