Biomass Cofiring Overview

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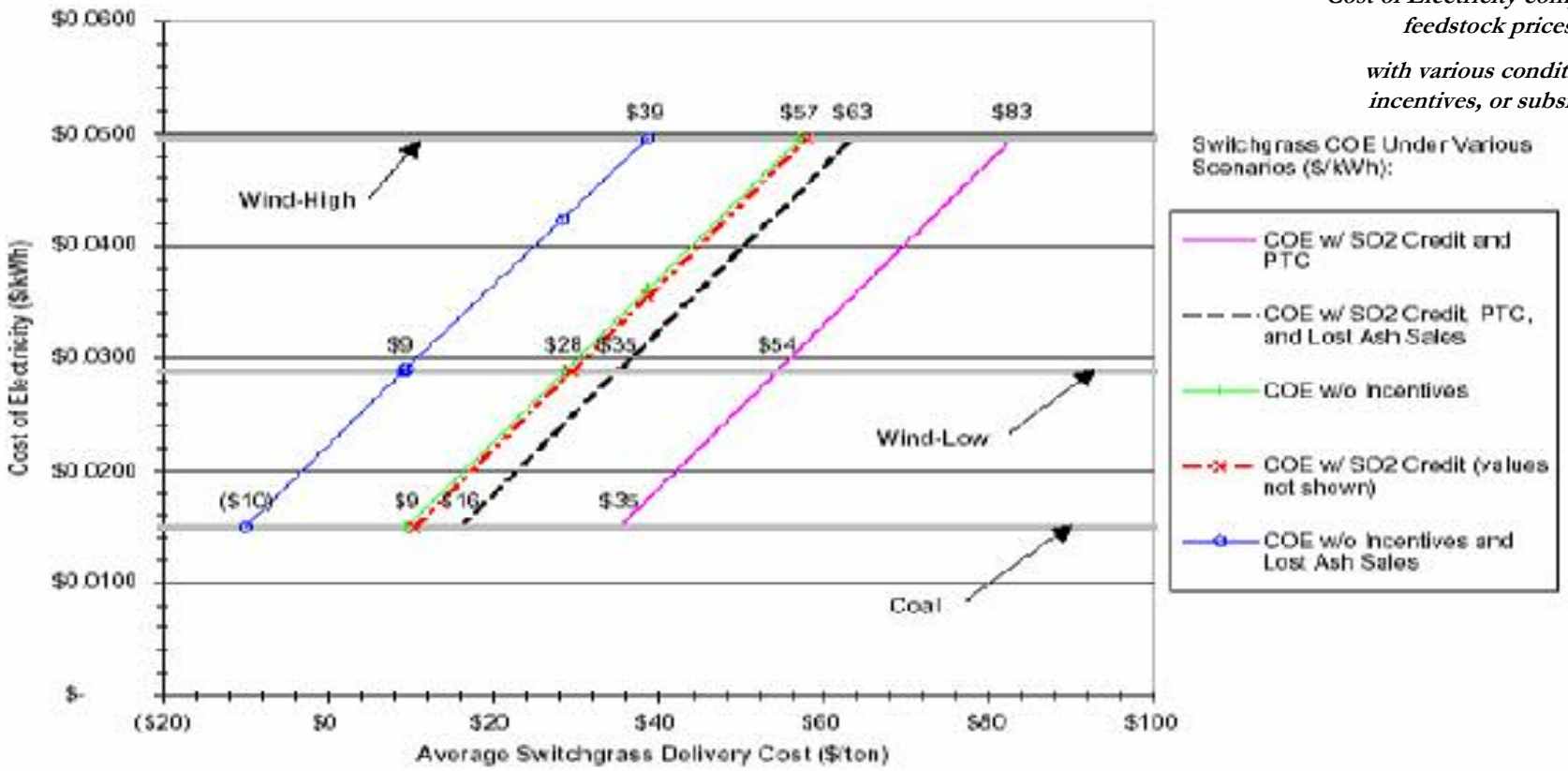
Second World Conference on Biomass for Energy, Industry, and World Climate Protection
May 10-14, 2004
Rome, Italy

Biomass Energy Economics

Typical Cost of Energy from Conventional Co-firing Combustion



Cost of Electricity compared to feedstock prices,

with various conditions, incentives, or subsidies

Typical biomass Cost

(US$ per ton)

PTC – proposed production tax credit

Incentive, e.g., Green Pricing Premium

Acknowledgement: Graph provided by Antares Group Inc

US Commercial Experience

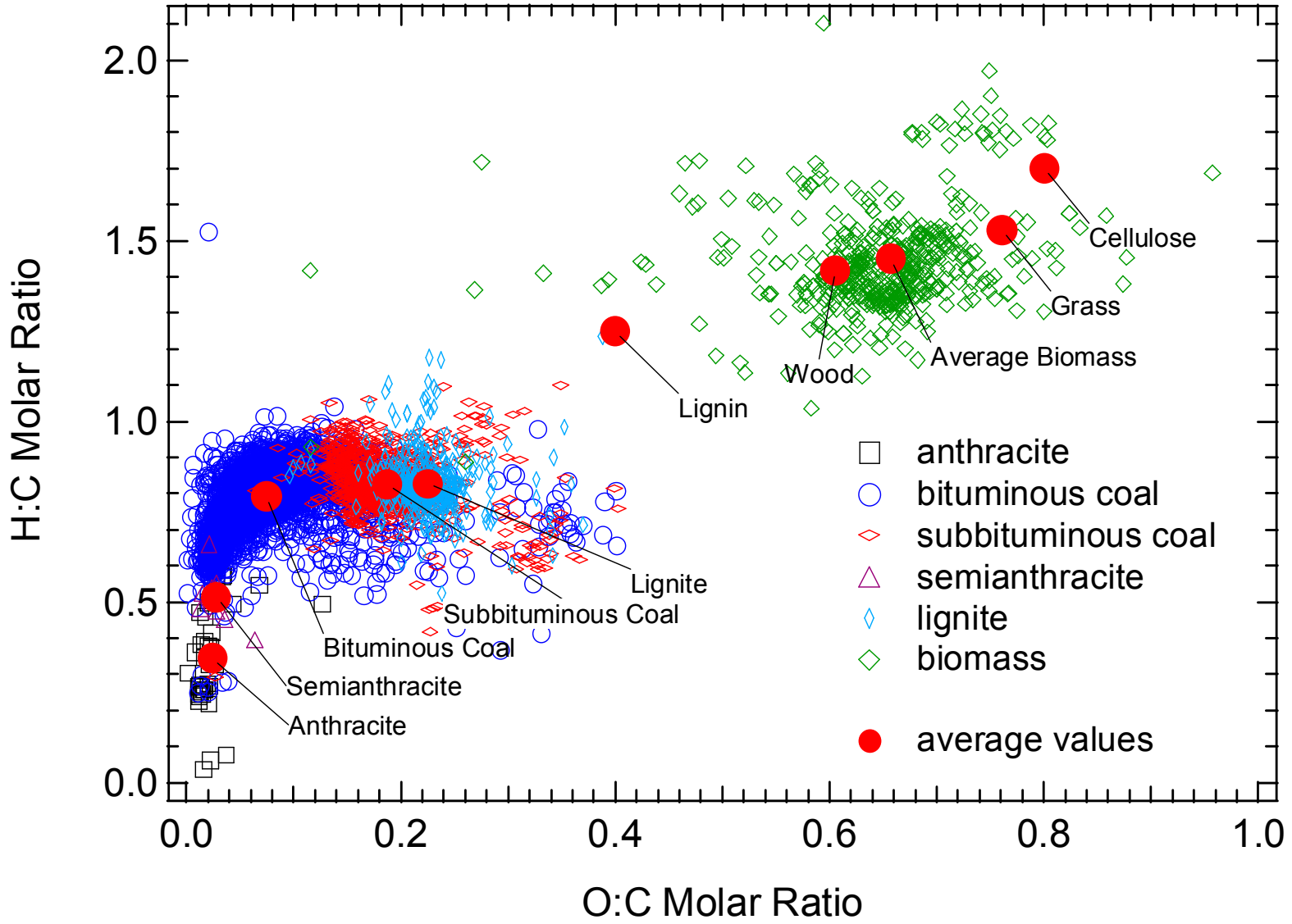
- Over 40 commercial demonstrations
- Broad combination of fuel (residues, energy crops, herbaceous, woody), boiler (pc, stoker, cyclone), and amounts (1-20%).
- Good documentation on fuel handling, storage, preparation.
- Modest information on efficiency, emissions, economics.
- Almost no information on fireside behaviors, SCR impacts, etc.

Major Technical Cofiring Issues

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

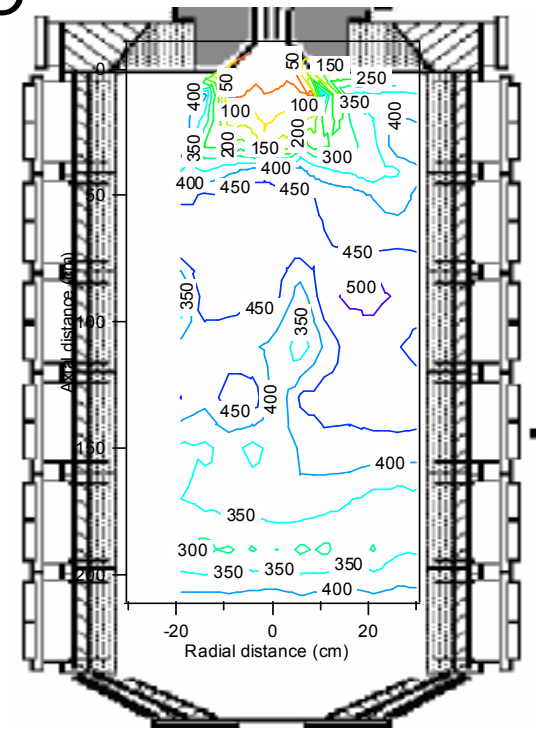
Lab and field work indicate there are no irresolvable issues, but there are poor combinations of fuel, boiler, and operation.

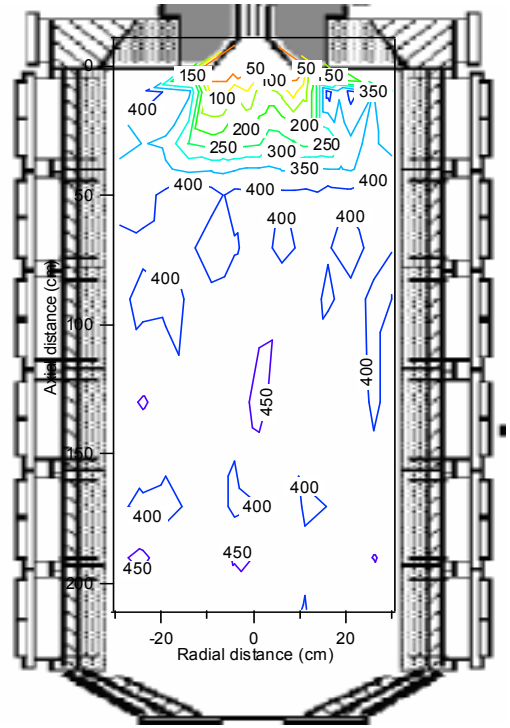
Fuel Properties

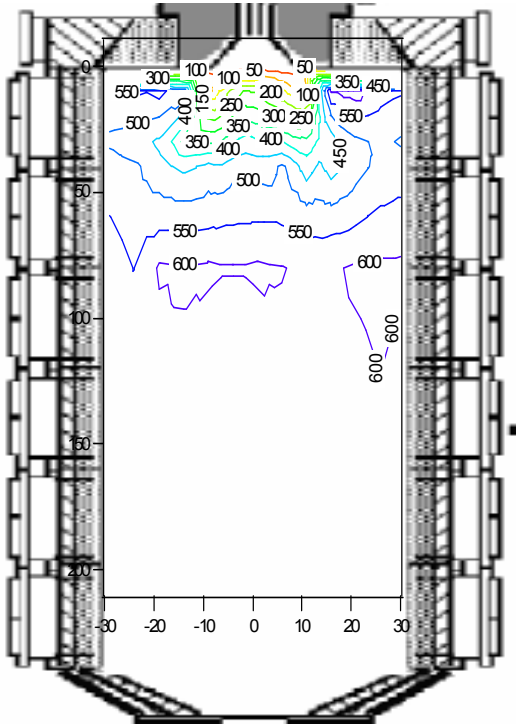


NO_x Behavior Complex (No Surprises)

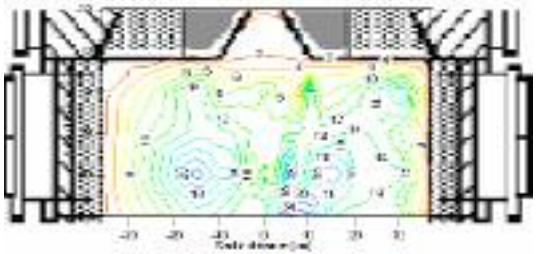
NO

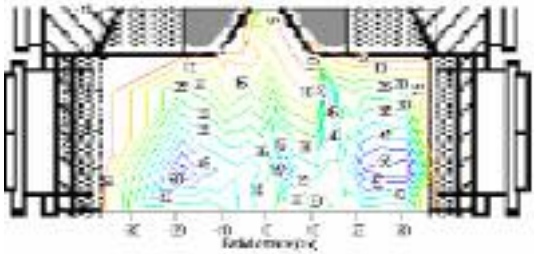


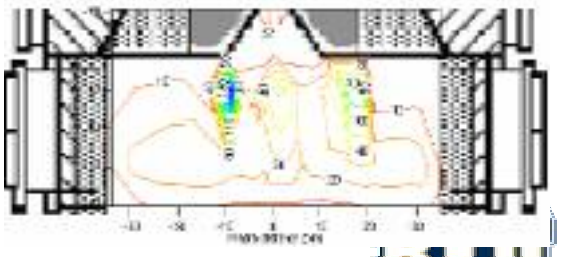




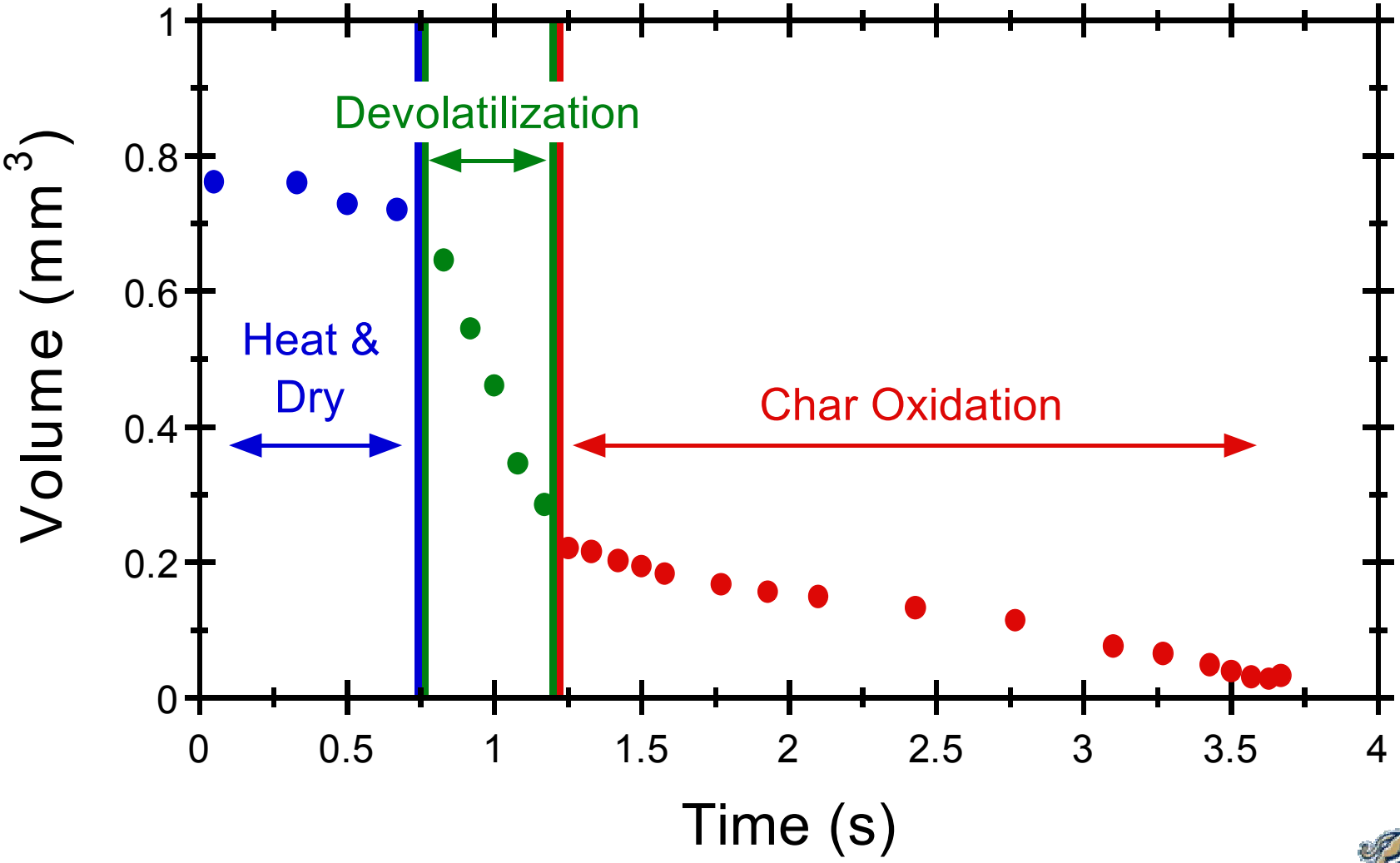
NH_3 Straw (ϕ = 0.6) Coal (ϕ = 0.9) 70:30 Straw:Coal (ϕ = 0.9





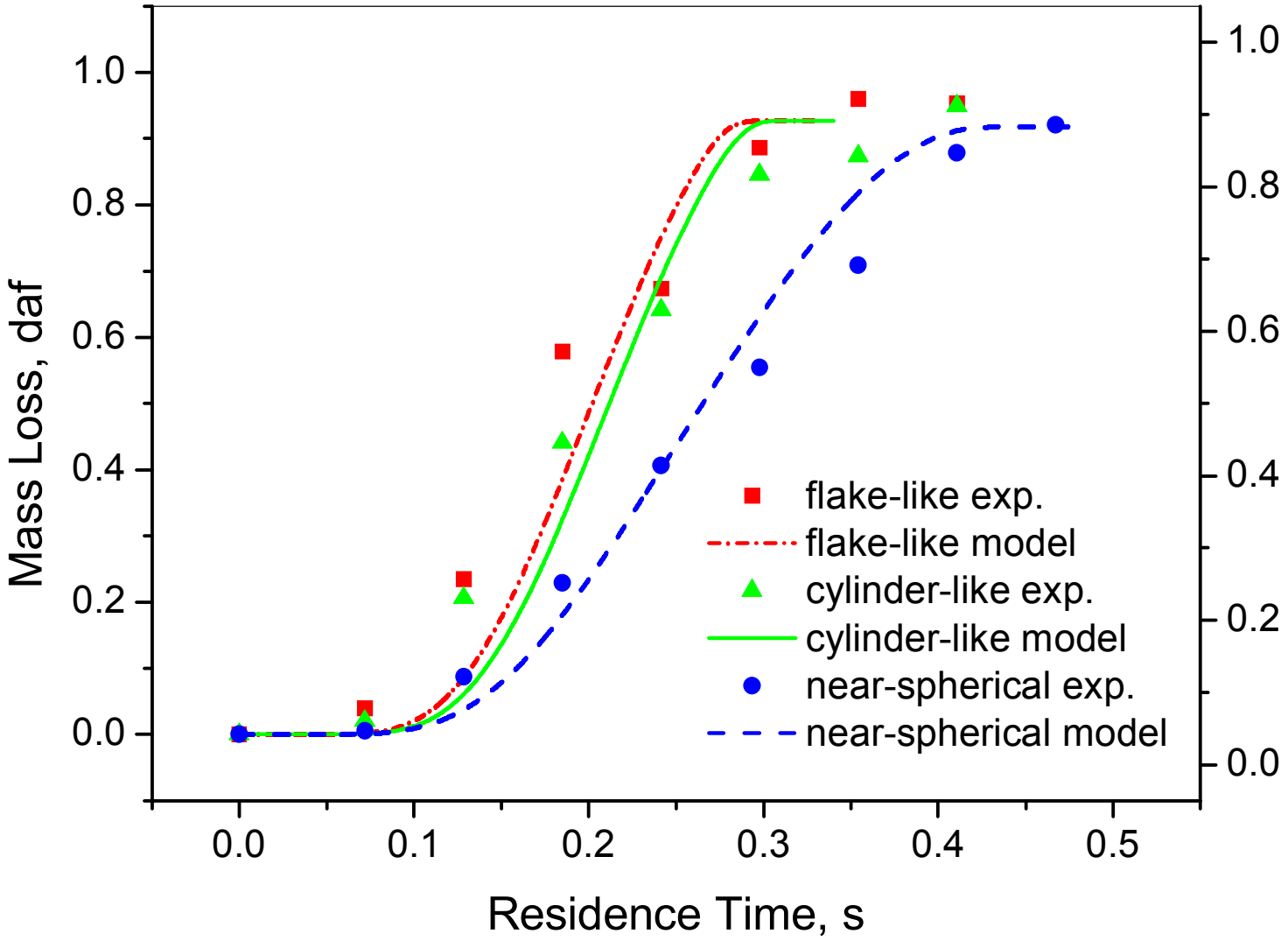


Combustion History: Switchgrass

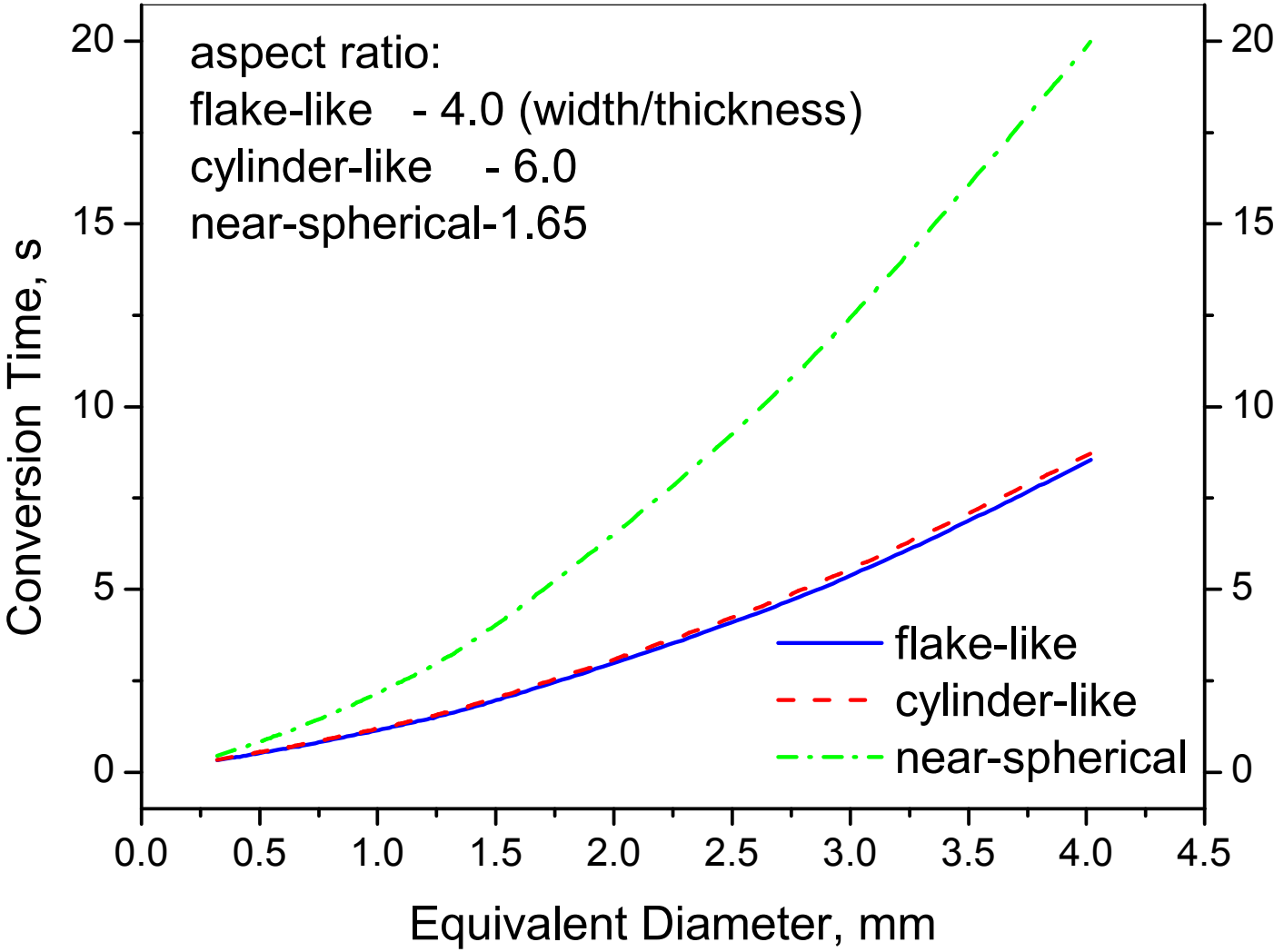


Initial nominal diameter = 3 mm

Particle Shape Impacts



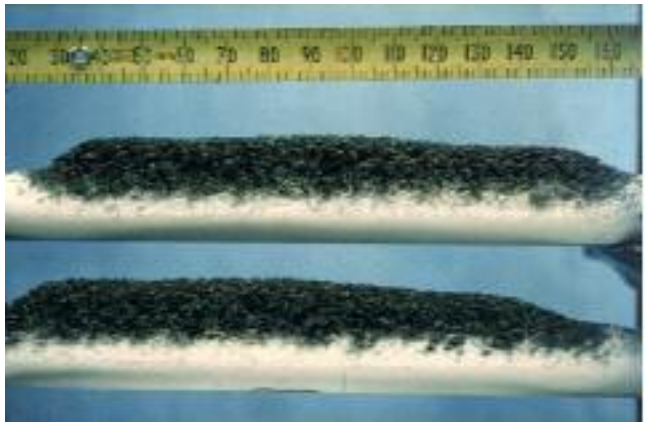
Reaction Time vs. Yield



Cofiring Deposition

1

2

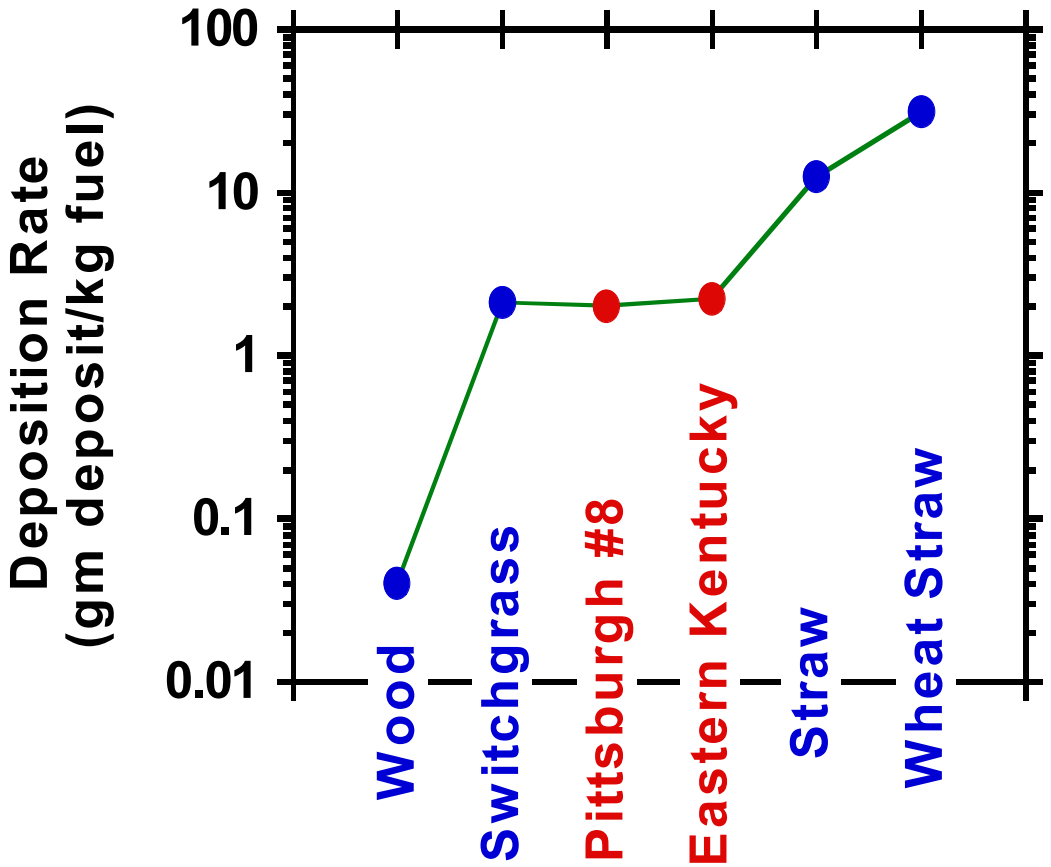


3

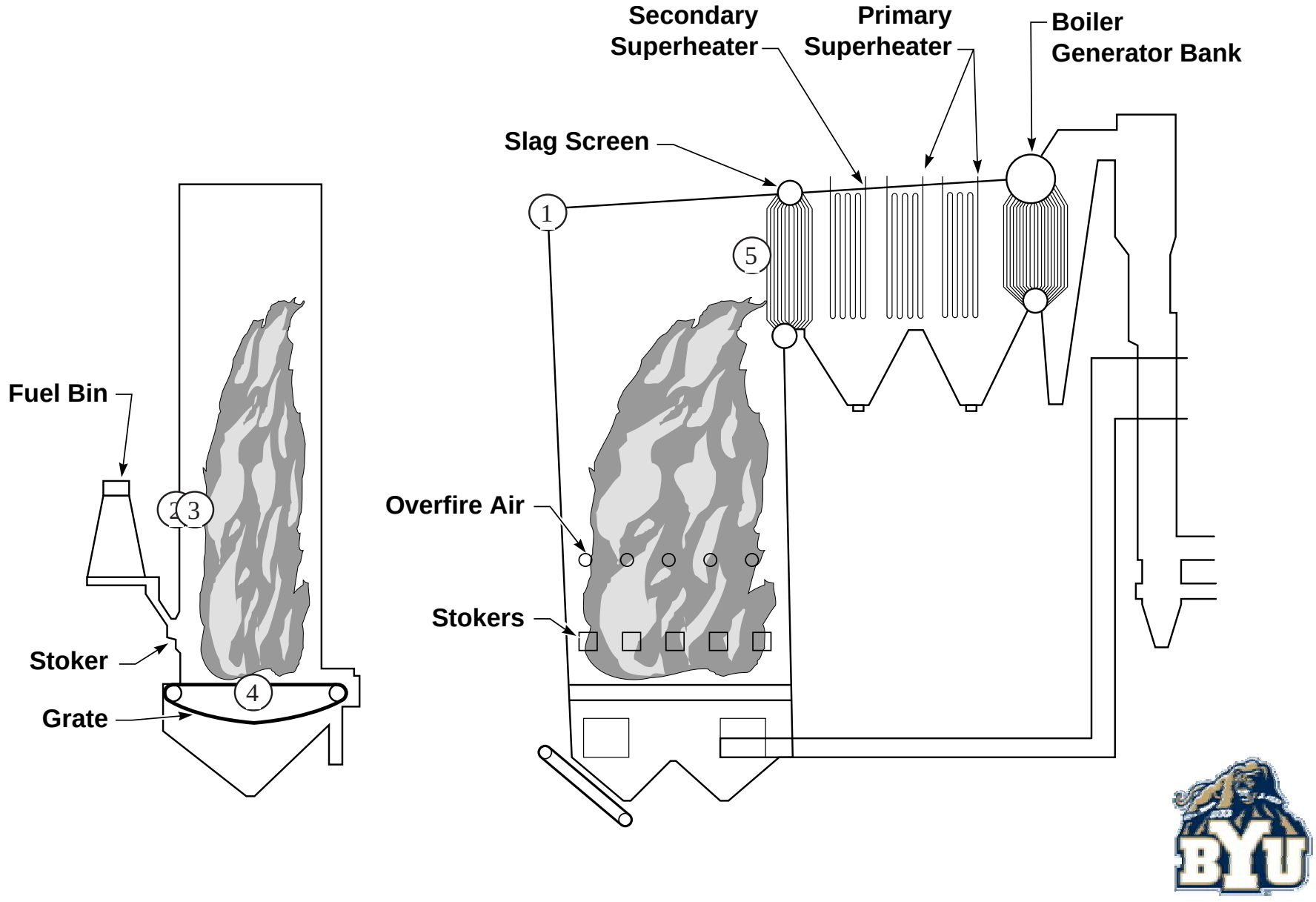
4

Deposition Rates Vary Widely

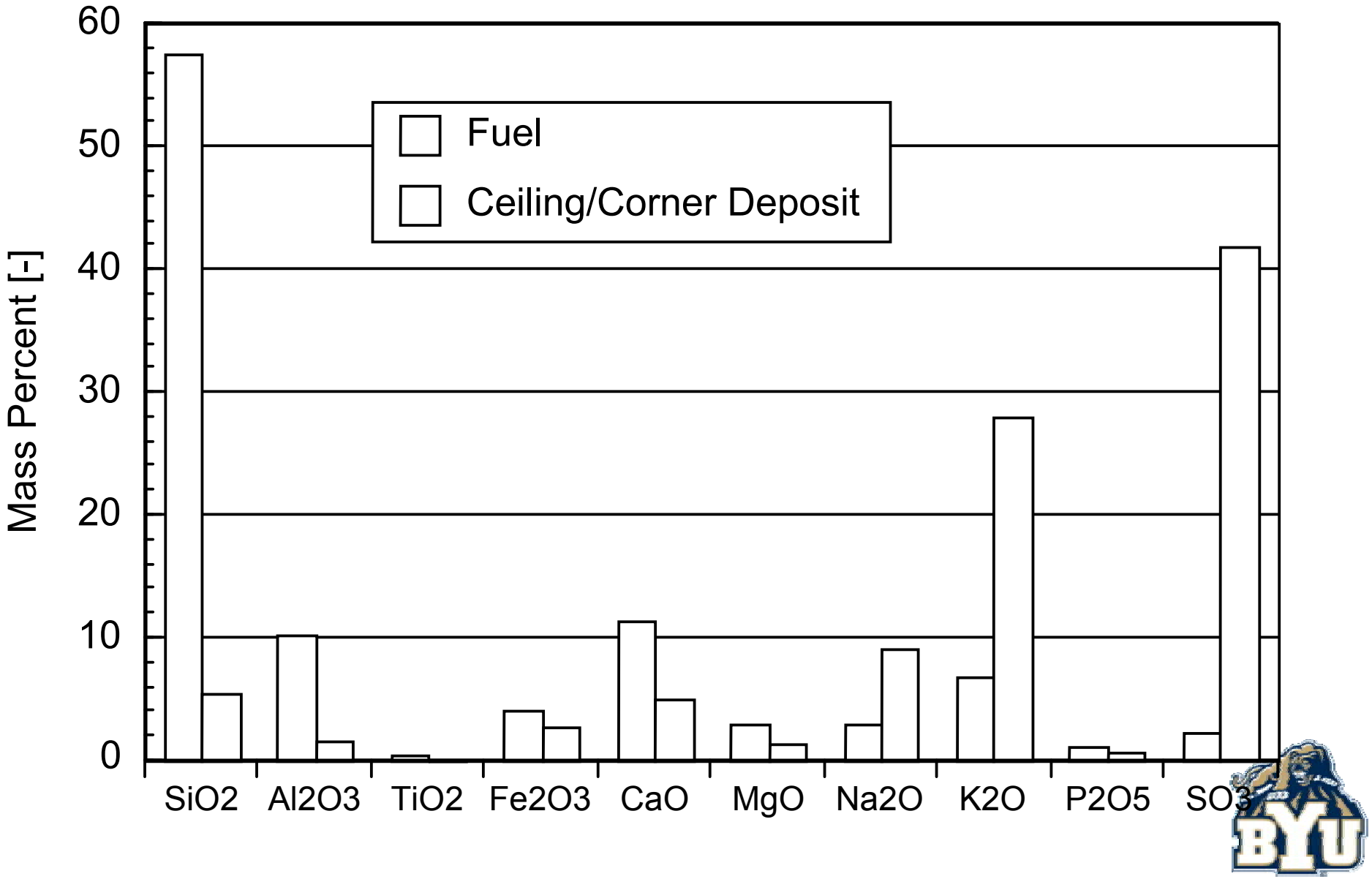
- Cofiring biomass can lead to either decrease or increase in deposition rates.
- Cofiring decreases deposition relative to neat fuels.



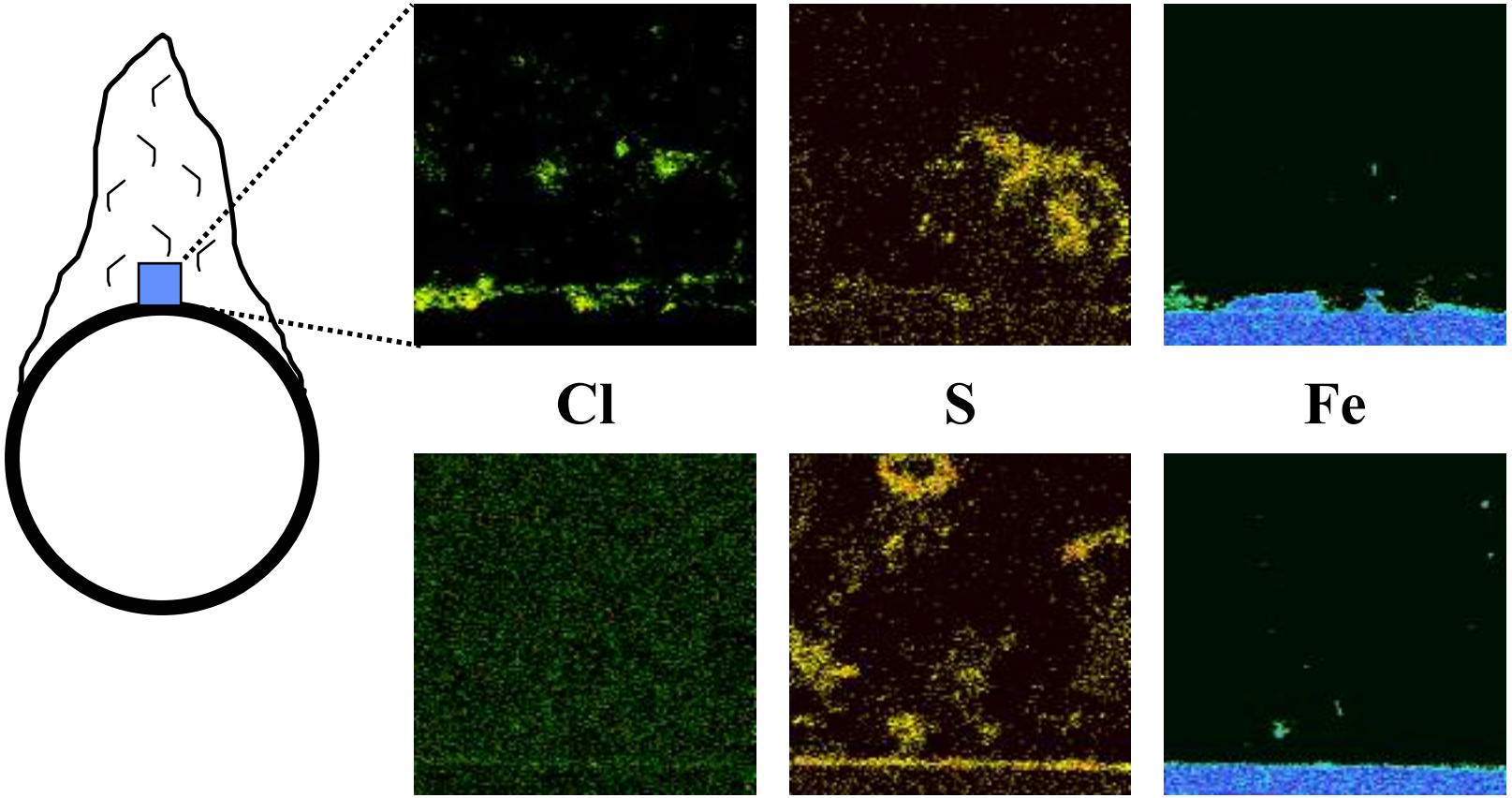
Commercial Stoker



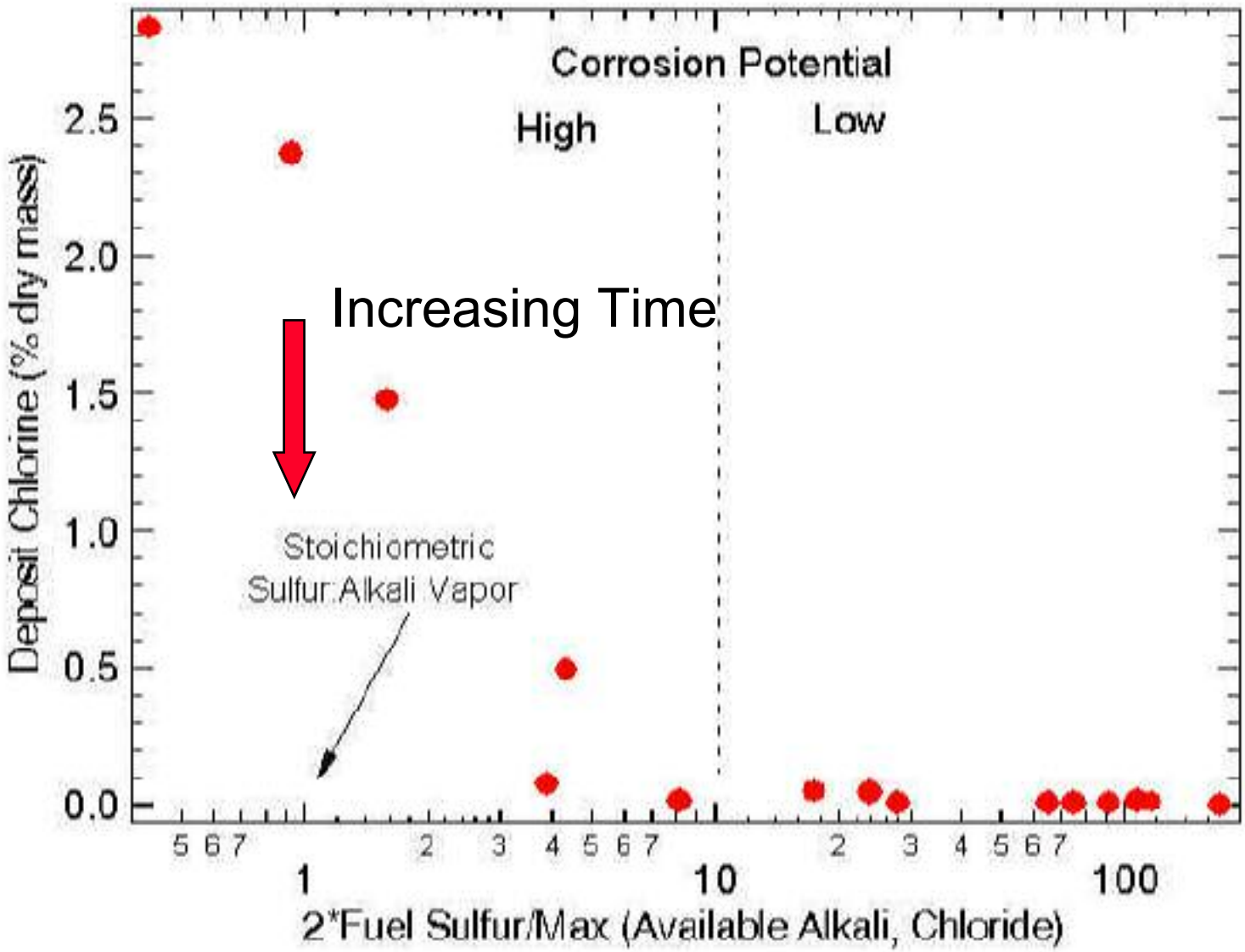
Deposits Dissimilar to Fuel

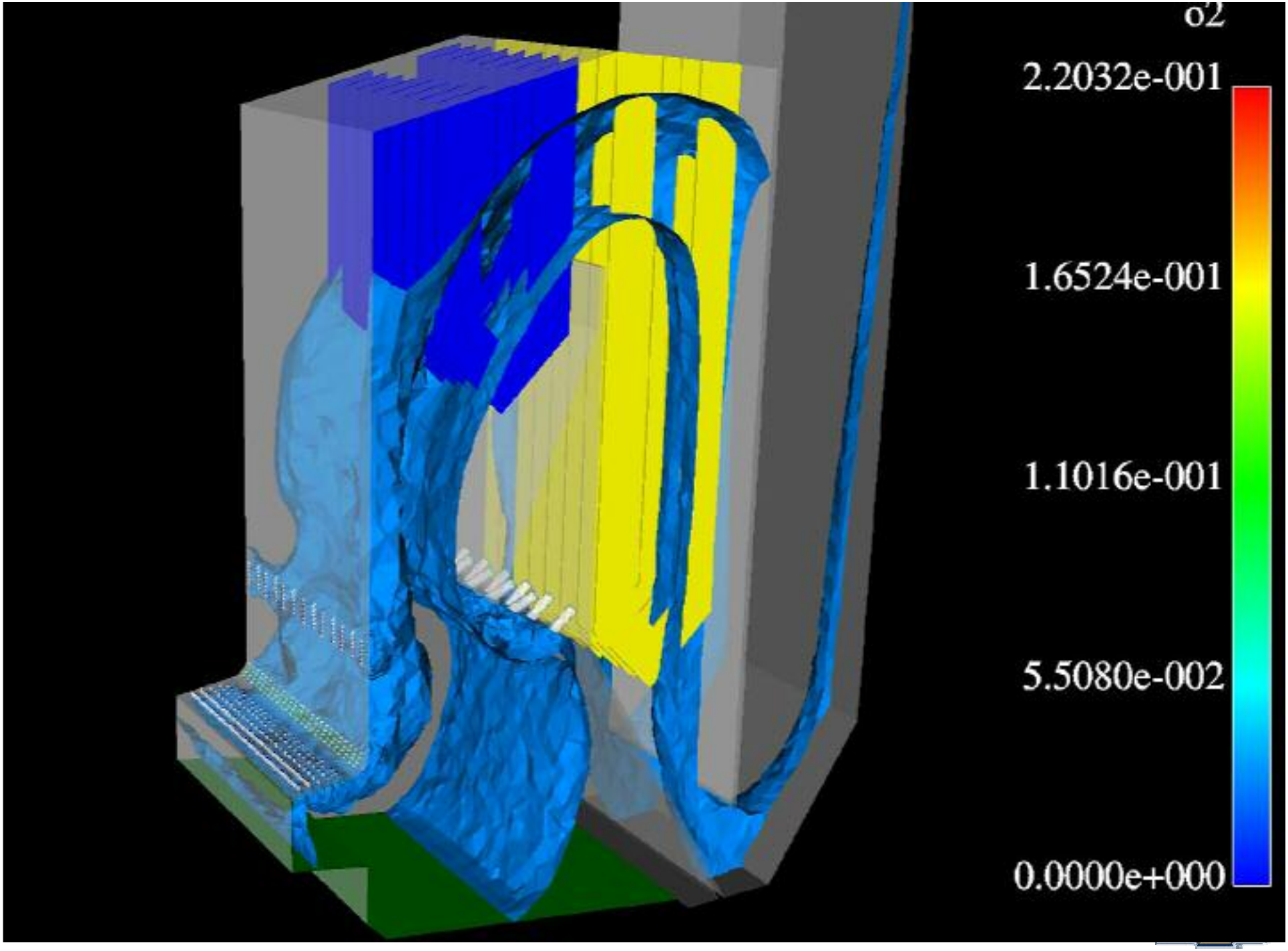


Composition Maps Support Corrosion Hypothesis



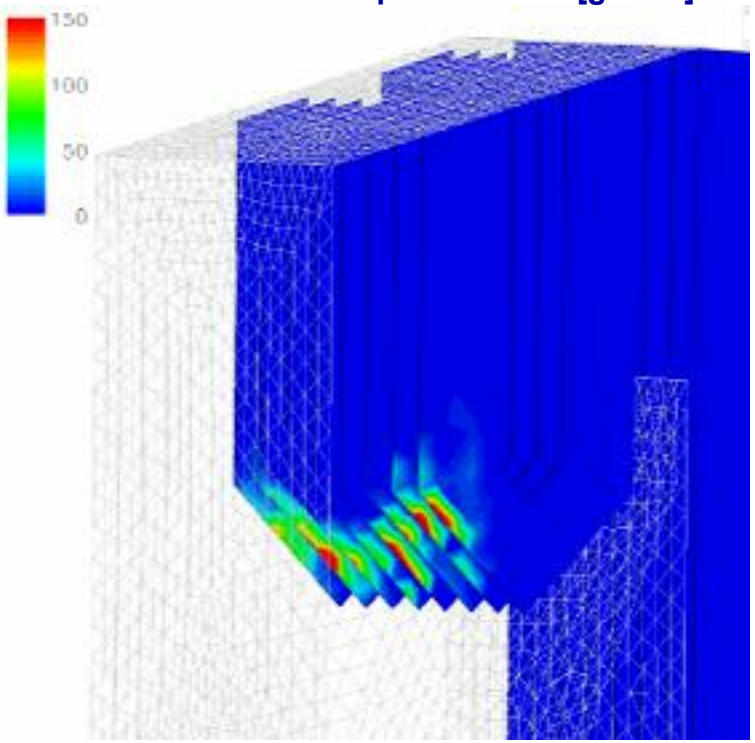
Fuel Properties Predict Corrosion



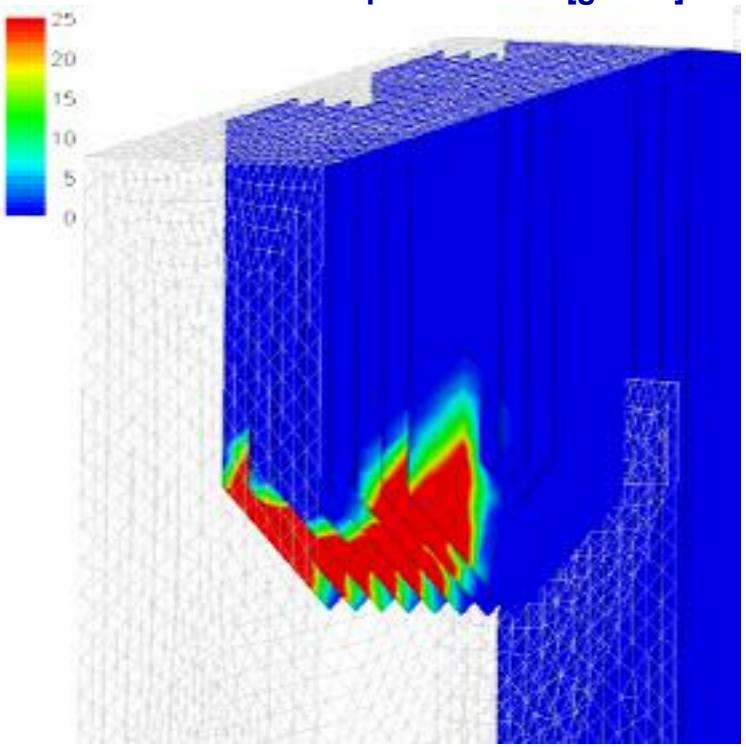

o2
2.2032e-001
1.6524e-001
1.1016e-001
5.5080e-002
0.0000e+000

BL mechanisms

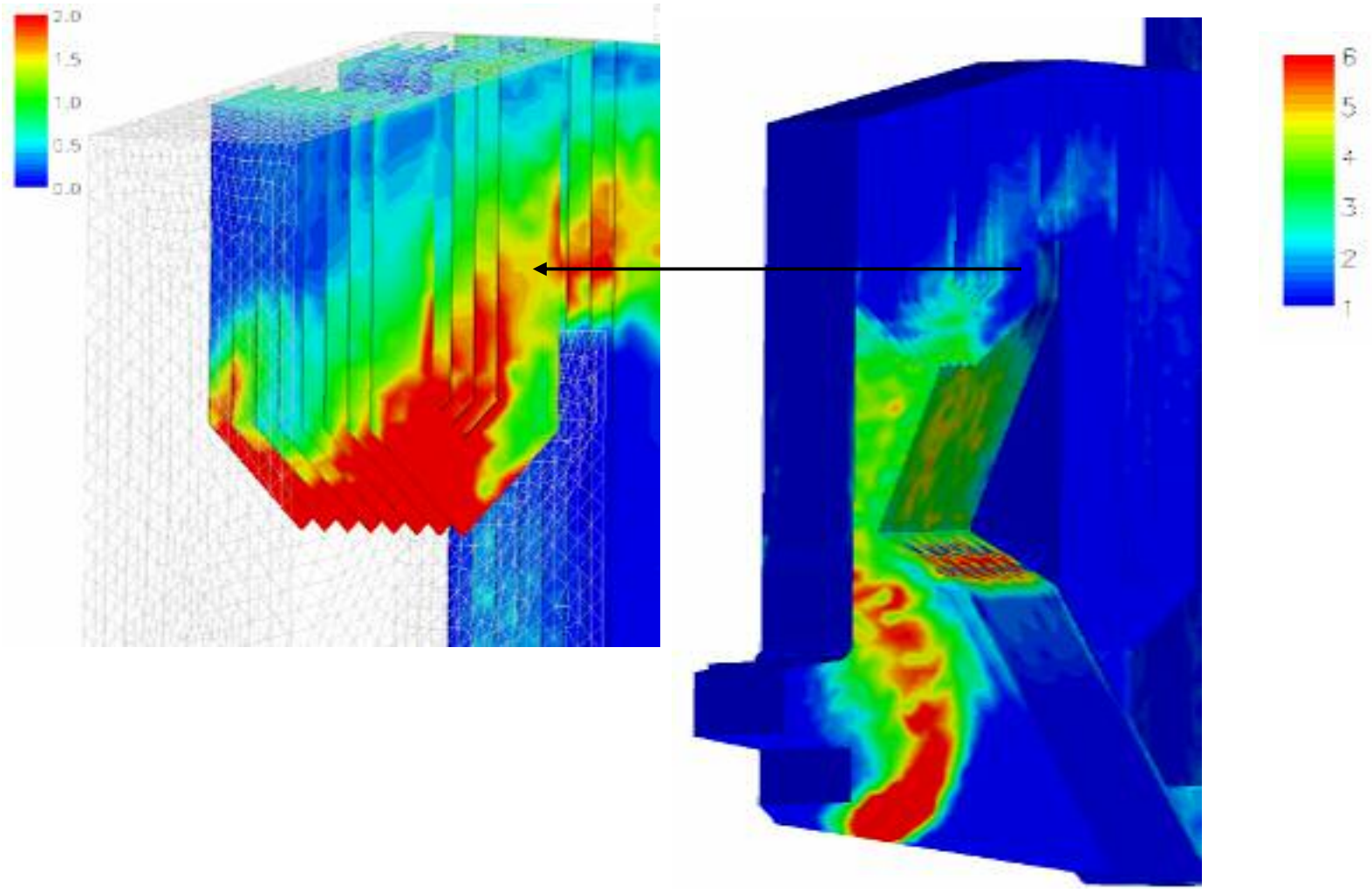
Inertial deposition flux [g/m^2/h]



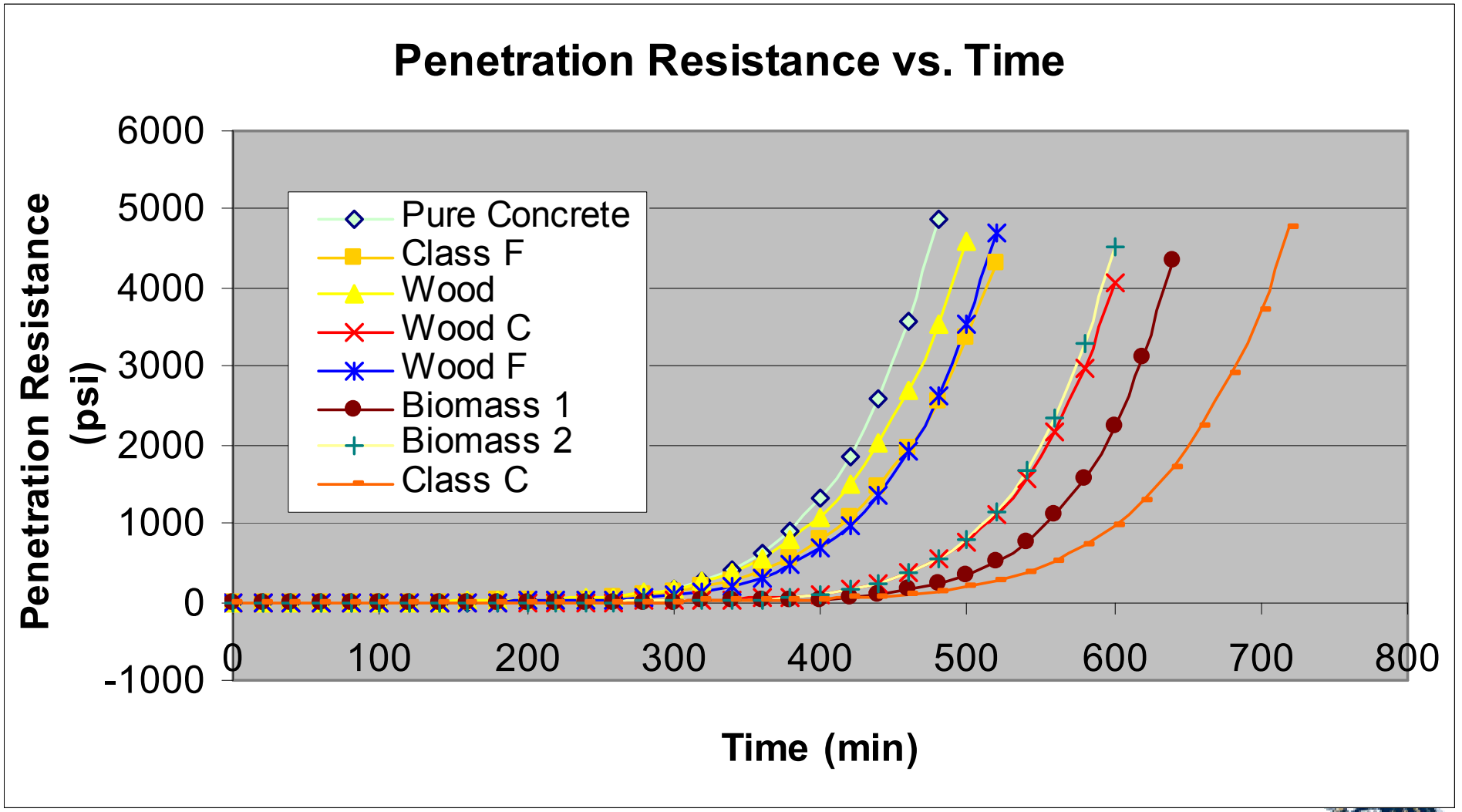
BL deposition flux [g/m^2/h]



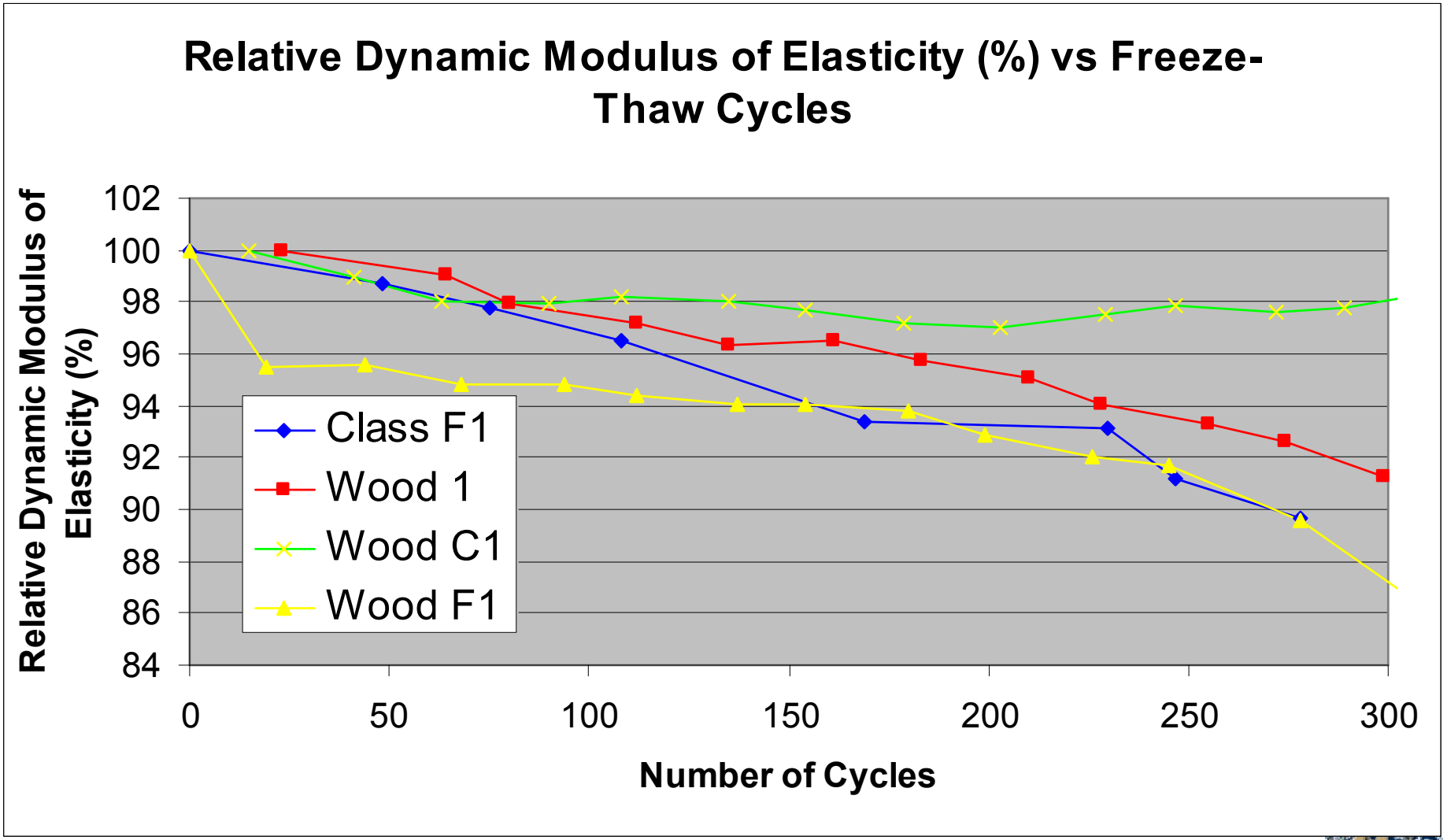
Vapor deposition



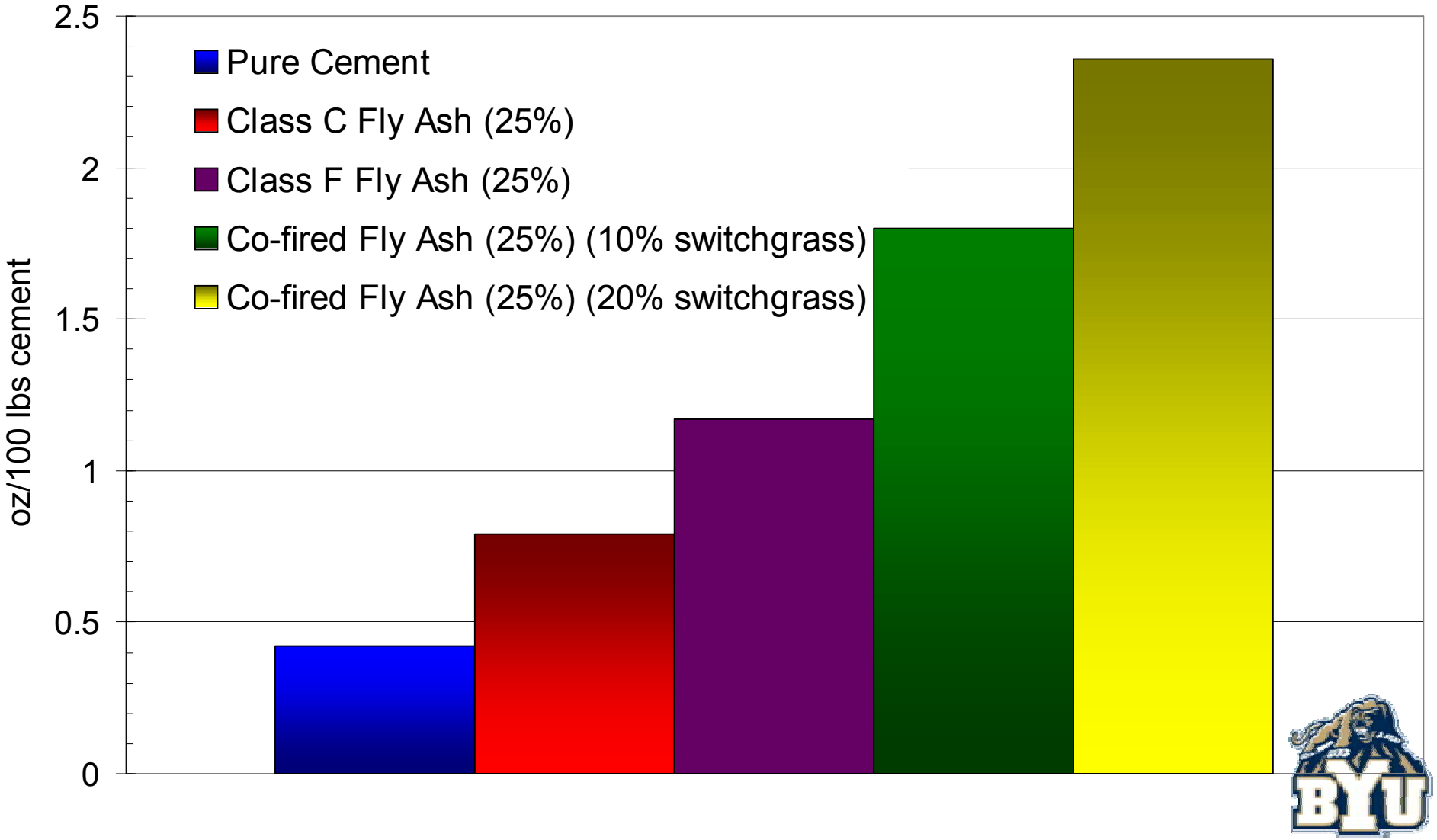
Flyash Impacts on Setting Time



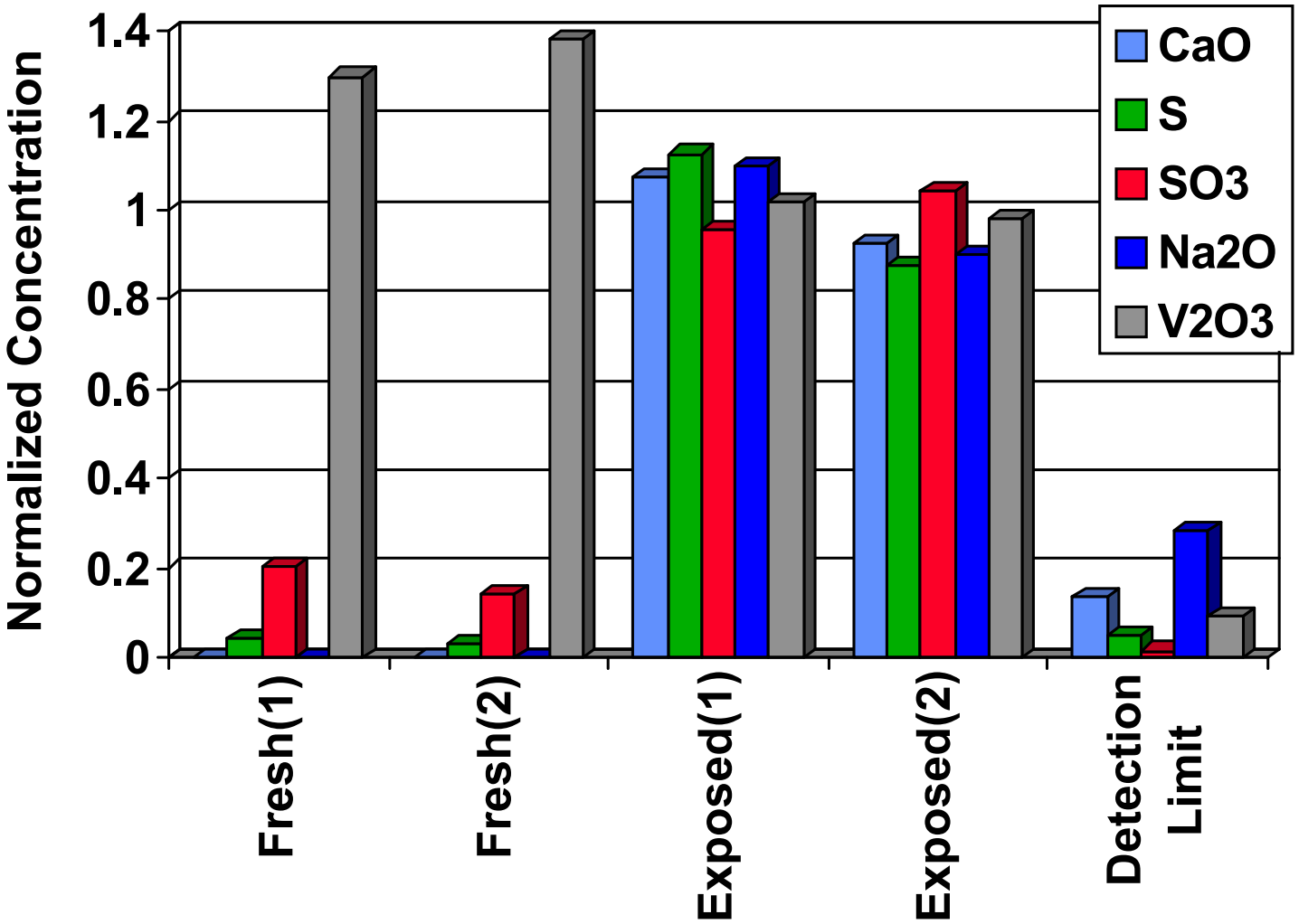
Freeze Thaw Cycles



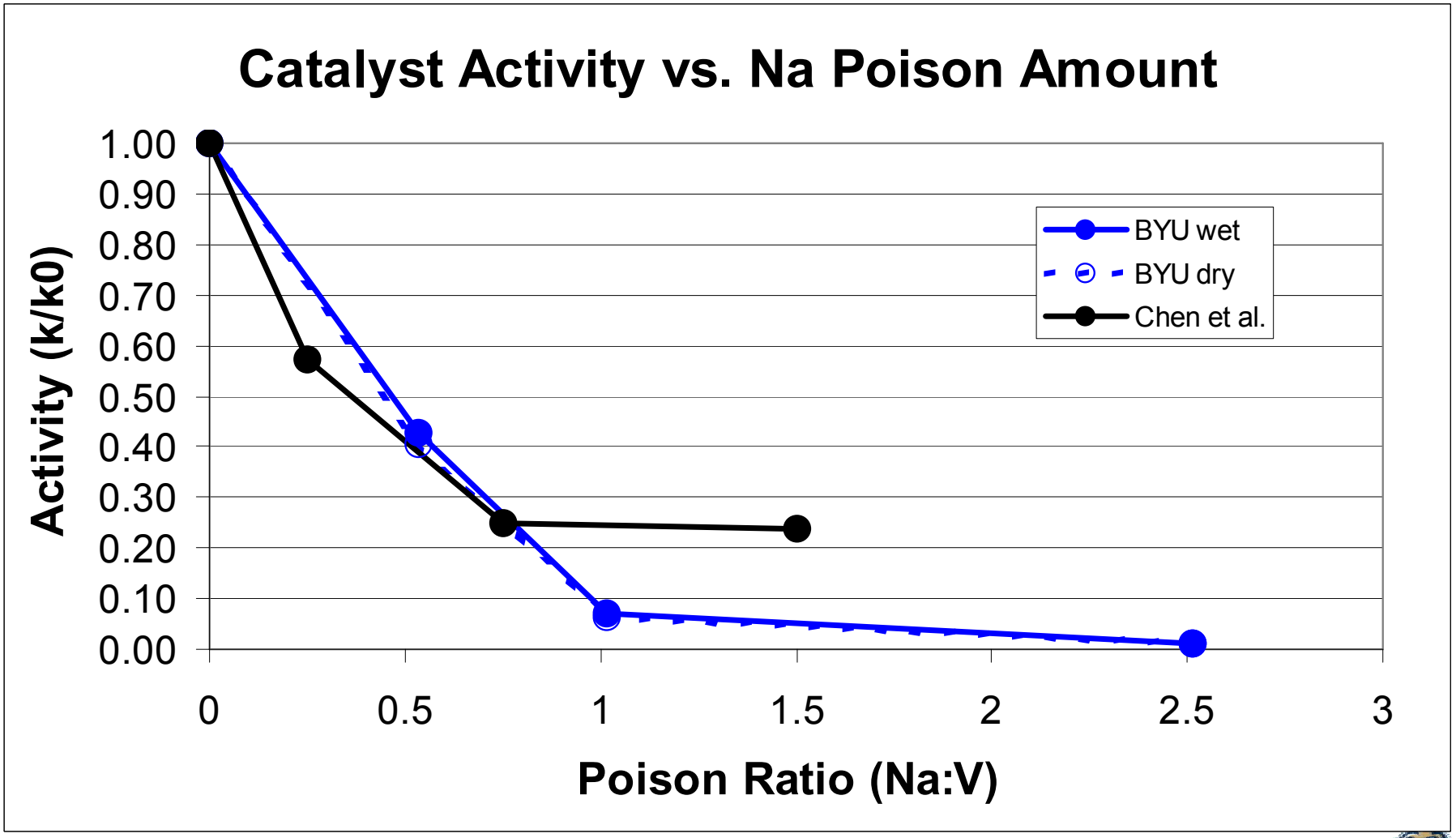
Required Aerating Agent



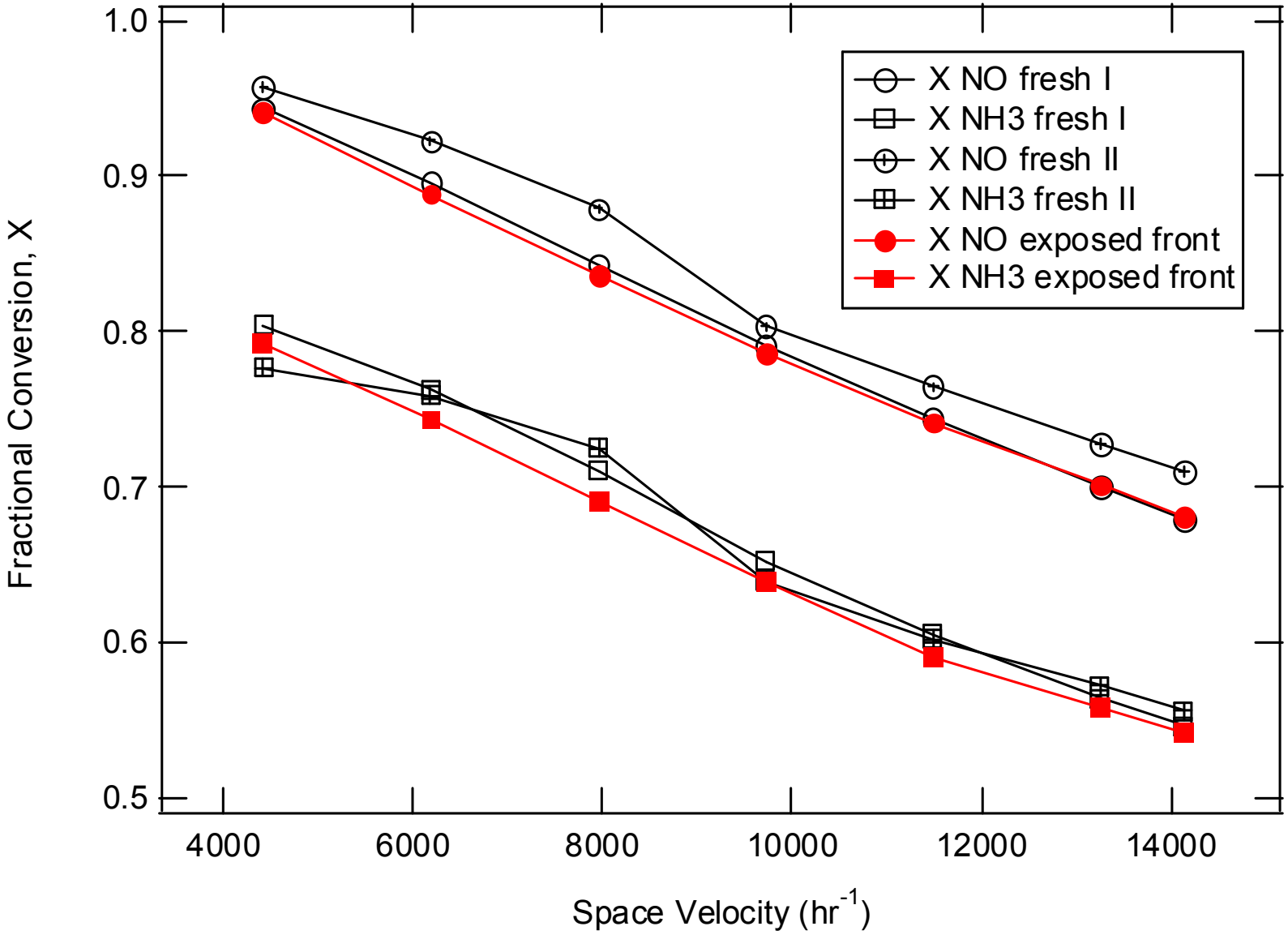
Surface Conditions of Catalyst



Basic Compounds Poison Catalysts



Field Tests Indicate Little Poisoning



Conclusions

- Major technical issues include fuel handling, storage, and preparation; NO_x formation; deposition; corrosion; carbon conversion; striated flows; effects on ash; impacts on SCR and other downstream processes.
- Importance of these issues depends strongly on fuel, operating conditions, and boiler design.
- Proper choices of fuels (coal *and* biomass) and operating conditions can minimize or eliminate most impacts for most fuels.
- Ample short-term demonstrations illustrate fuel handling feasibility. Paucity of fireside and long-term data.

Summary Cofiring Statements

- Cofiring has been demonstrated succesfully in over 150 installations worldwide for most combinations of fuels and boiler types.
- Cofiring offers among the highest electrical conversion efficiencies of any biomass power option.
- Cofiring biomass residues in existing coal-fired boilers is among the lowest cost biomass power production options.
- Well-managed cofiring projects involve low technical risk.

Cofiring biomass in existing coal-fired boilers provides an attractive approach to nearly every aspect of project development.

Outline

- Introduction
- Success stories
- Statements
- R&D&D for improvement
  - Long term experience
  - Fireside measurements in commercial scale facilities
  - SCR deactivation
  - Fly ash utilization
  - Deposition and corrosion
  - Striated flows
  - Fuel specifications, preparations and limitations
  - Public awareness/image
  - Increasing cofiring percentages

Acknowledgements

- Financial support provided by the DOE/EE, EPRI, NREL, BYU, a dozen individual companies.
- Work performed by research group including four other faculty members, two post docs, ten graduate students, 30 undergraduate students.