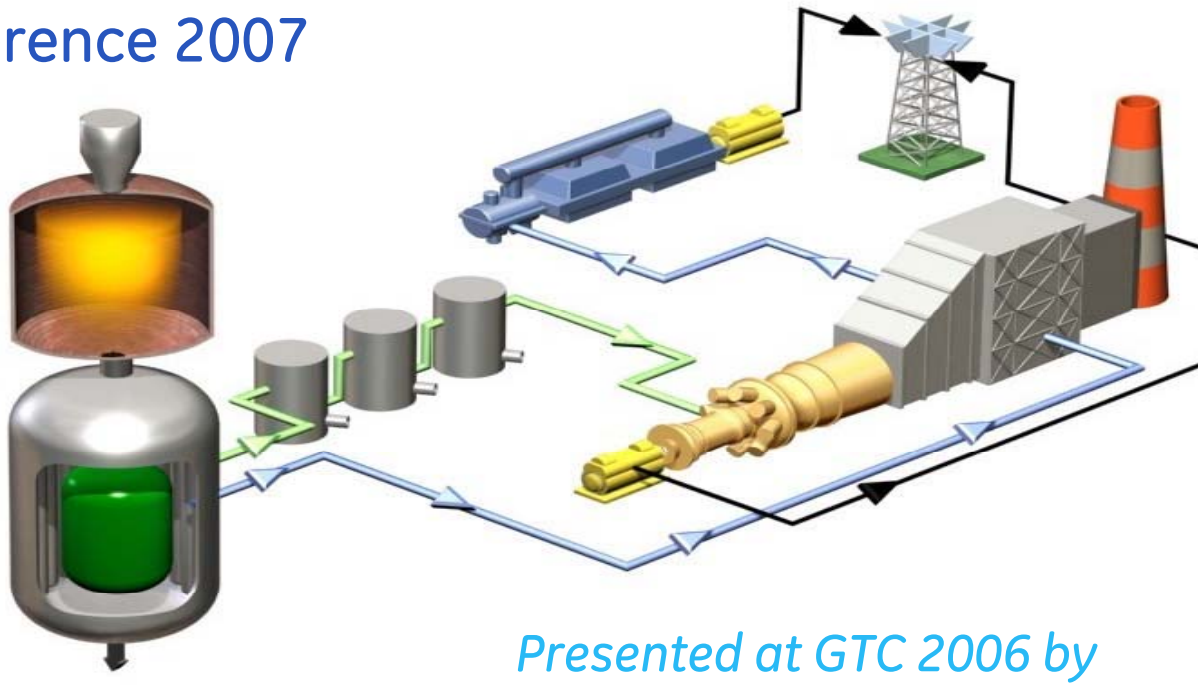
Overview of Gasification Activities at GE

George Rizeq
GE Global Research

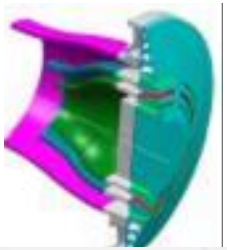
ACERC Annual Conference 2007
BYU, Provo, UT
27th Feb 2007

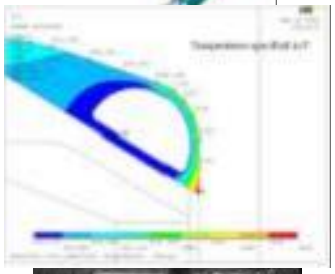


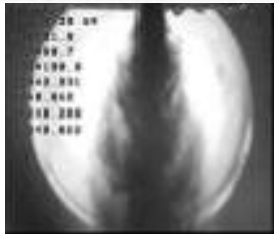
imagination at work

Presented at GTC 2006 by Monte Atwell (GE Energy)

Technology Drivers







Reference Plant System Design Concept

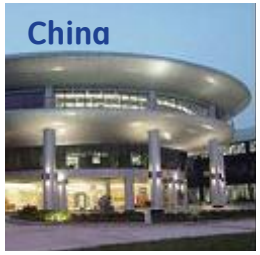
- Reduce Capital Costs
- Optimized Design Integration

Performance – System/Component

- Efficiency & Operability
- Reliability, Availability, Maintenance (RAM)

Time to Maturity

Leveraging The "Bigger GE"



Global Technology Team

Houston, TX – Process & Product Design & IGCC Experience

Niskayuna, NY – Materials, Design, System Analysis

Shanghai, China – Materials, Chemistry, Instrumentation

Schenectady, NY/ Salem, VA – Controls, Simulation

Bangalore, India – Computational, Experimental

Greenville, SC – Design, Adv Materials & Manufacturing

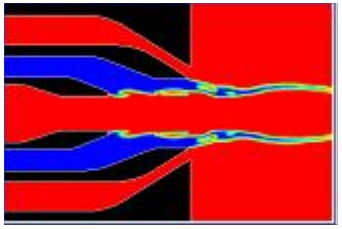
Irvine, CA– Gasification Modeling & Experimental Activities

> 300 Engineers & Scientists

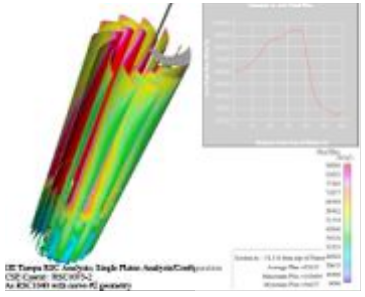
New Product Introduction Strategy

Models

Coal Slurry Spray

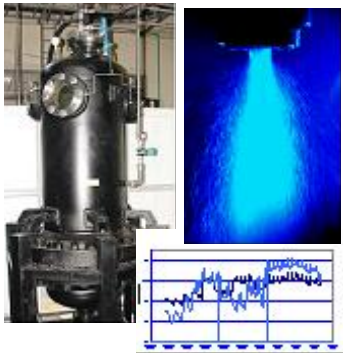


Gas Flow & Heat Recovery

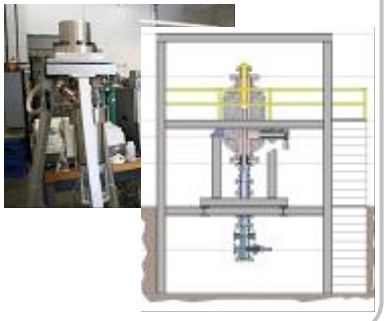


Lab Tests

Injection Test

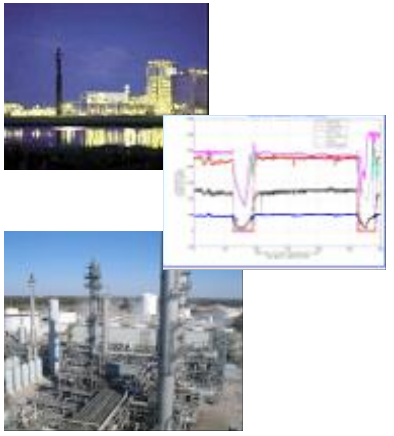


Gasification Kinetics

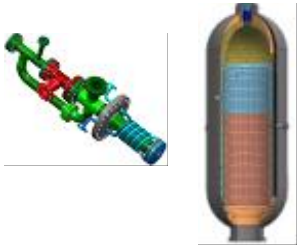


Field Tests

Validation Data

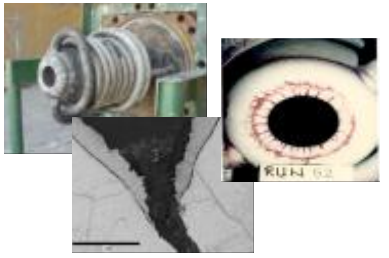


Field Optimization

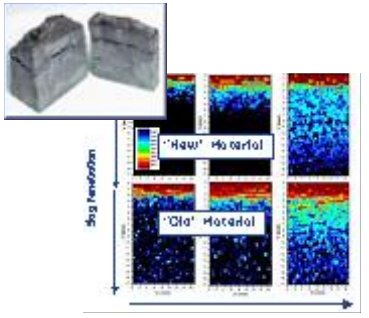


Materials

Metal



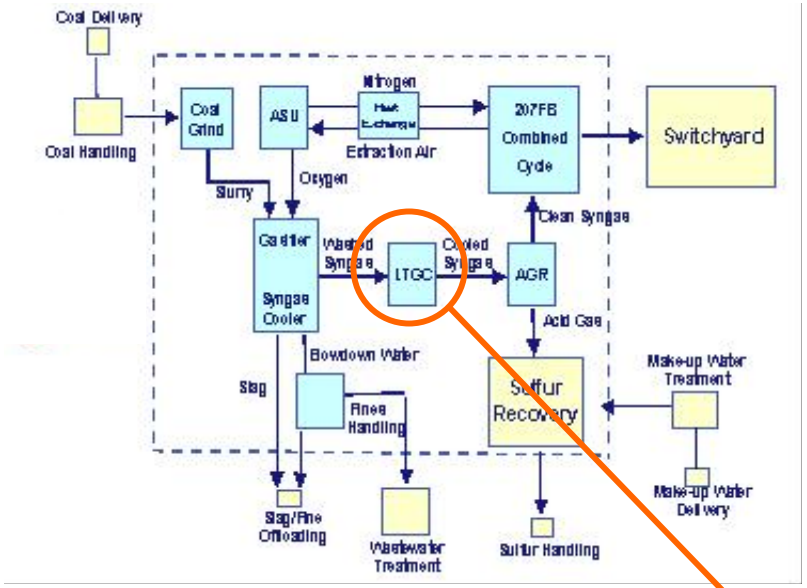
Coatings & Refractory



TG1 → TG2 → TG3 → TG4 → TG5 → TG6 → TG7

Toll-gated NPI Process

Systems Integration



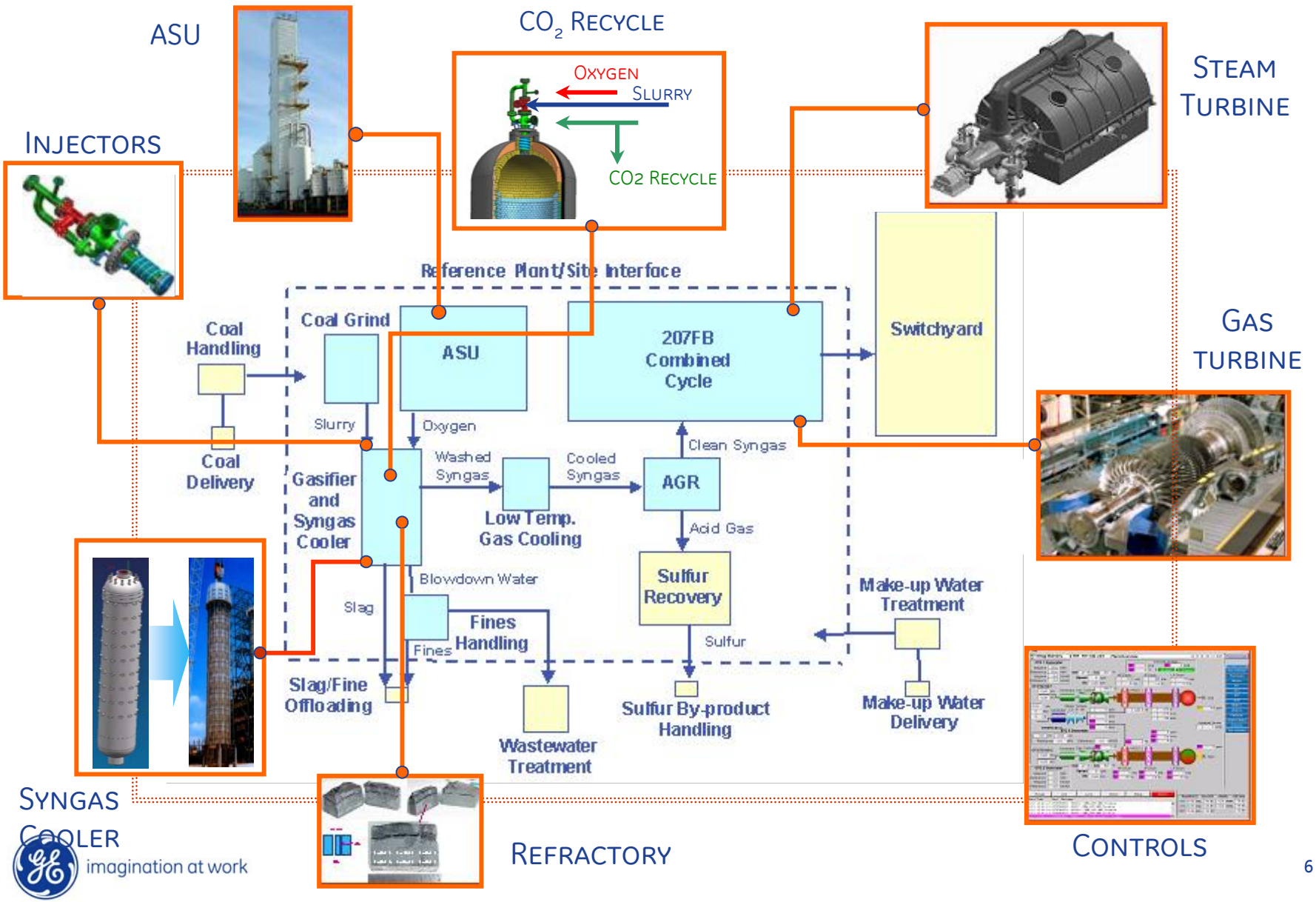
System Level View

- Plant Level Performance & Optimization
- Specification flow-down to sub-systems
- Sub-system integration

IGCC Reference Plant Sub-System Ownership Summary		
Description	Sub- Systems Owners	
Plant Performance	Matt King	John Gulen
System Interface Control	William Yen	Eileen Nguyen
System Operability	Raub Smith	Raub Smith
Steam, Condensate, and BFW system	Matt King	John Gulen
Coal Grinding/Slurry Prep	Natesh C.	Natesh C.
Gasification and Scrubbing (ex. RSC)	George Gulko	George Gulko
Radiant Syngas Cooler System (RSC)	James Storey	James Storey
Coarse Slag Handling	Lorena Sullivan	Lorena Sullivan
Black Water Flash	Ellen Norwood	Ellen Norwood
Fine Slag Handling	Lorena Sullivan	Lorena Sullivan
Condensate Ammonia Stripper	George Gulko	George Gulko
Low Temperature Gas Cooling	Ellen Norwood	Ellen Norwood
Acid Gas Removal	S. Naphad	S. Naphad
CO2 Recycle	P. Thacker	P. Thacker
Syngas Saturation	Rueben Aiton	Rueben Aiton
Grey Water Blowdown, Stripping, Ionics E	Ellen Norwood	Eileen Nguyen
Overall Process Water System	Ellen Norwood	Eileen Nguyen
Air Separation Unit	J. Kassman	J. Kassman
Diluent Conditioning/ Ext. Air Cooling	Matt Prater	Matt Prater
Power Block	B. Warner	B. Kump

Subsystem Ownership and Tollgate Process to Drive Design Integration at the System Level

Reference Plant NPI Programs



NPI Value Propositions – Feed Injector Case

Specification	Target
Conversion	+30%
Tip life	+100%
Turndown Capability	to 50%

↑ Carbon Conversion

↓ Fines in Slag

- Lower frequency of Lock-hopper dumps
- Reduced O&M of slag/carbon separation equipment

↓ Heat Rate

- Increased conversion → need for less fuel input to gasifier
- Greater net plant output

↓ Recycled Fines

- Reduction in chemical usage due to reduced solids loading in settlers
- Reduced solids carry-over to grey water tank increasing the life of downstream components

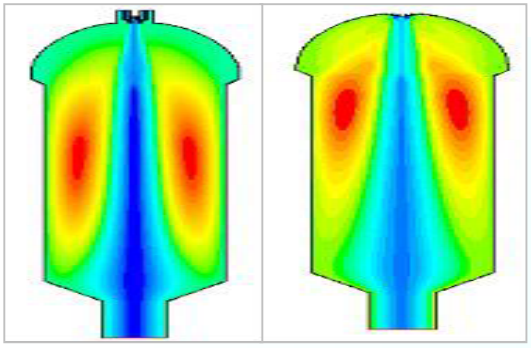
↓ Gasifier Operating Temperature

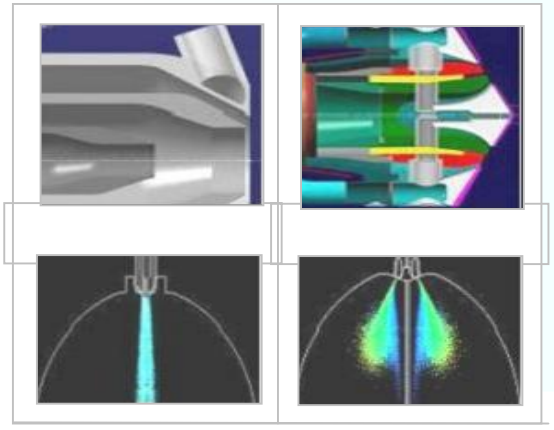
- Slag production is lower; the gasifier can be operated at a lower temperature
- Refractory life extension due to lower temperatures

Feed Injector Program

Models

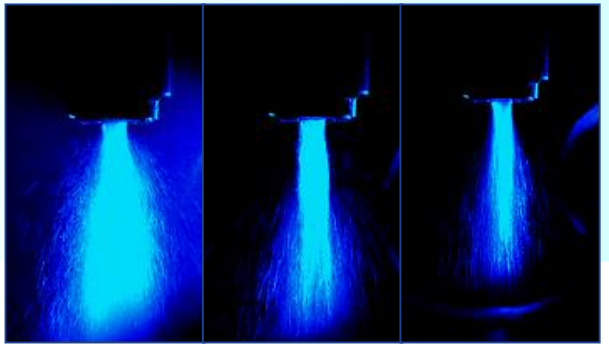
Injector D1 Injector D2



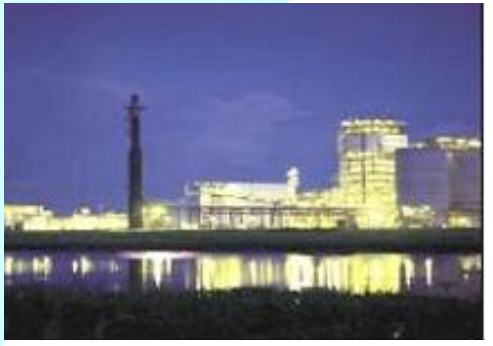


Lab Tests

Pressure vessel



Field Tests



Syngas Cooler Program

Define

Measure

Fouling Samples

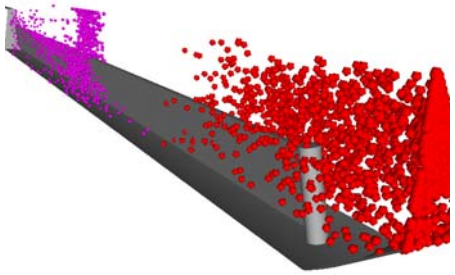
Validation

Fleet Leader Instrumentation

Design Cycle

Analytical Models & Experimental Validation

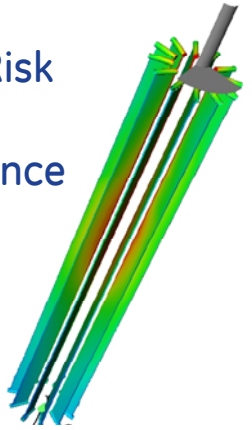
Analyze



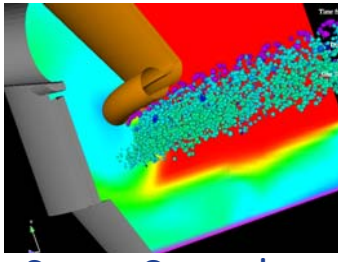
Deposition Modeling

Optimize

Cost vs. Risk vs. Performance



Design



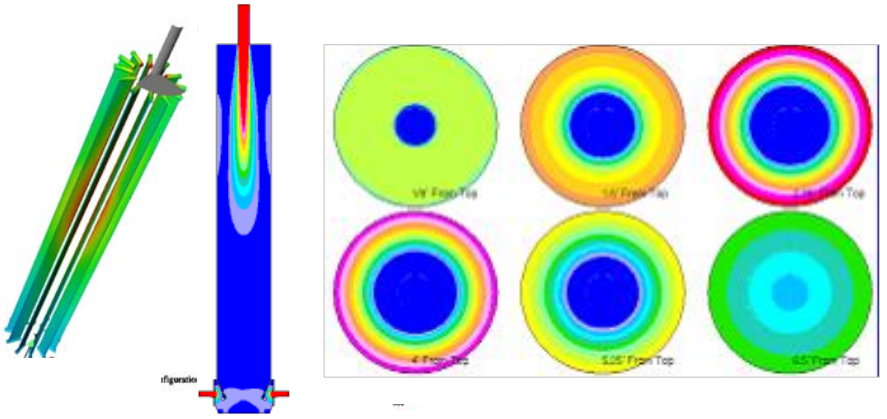
Spray Quench

Goals – CAPEX Reduction & Increased RAM

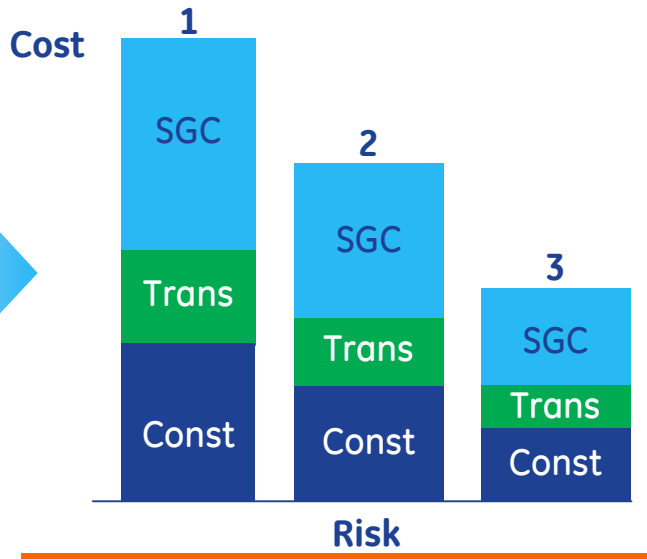
Syngas Cooler Modeling

CFD & FEA Modeling

Flow & thermal modeling



Design to Cost Efforts



Deposition Modeling

Sample Testing
Physics Based Modeling
Spatial Distribution

→ **Fouling Factor**

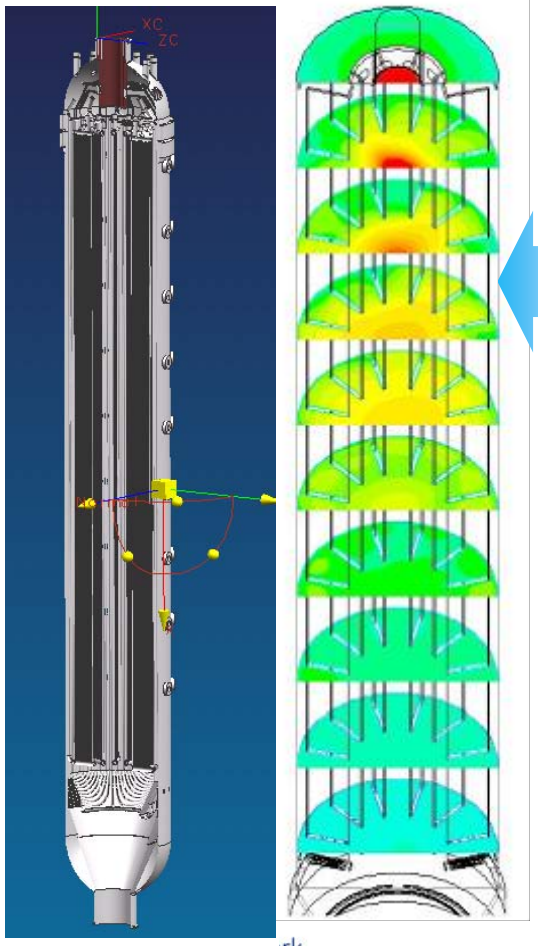
Size Reduction = Cost Reduction

Transportation & Construction

System level optimization for cooler, construction, & transportation

Syngas Cooler Design Validation

Create Models → **Collect Data** → **Update Model** → **Validate Model**

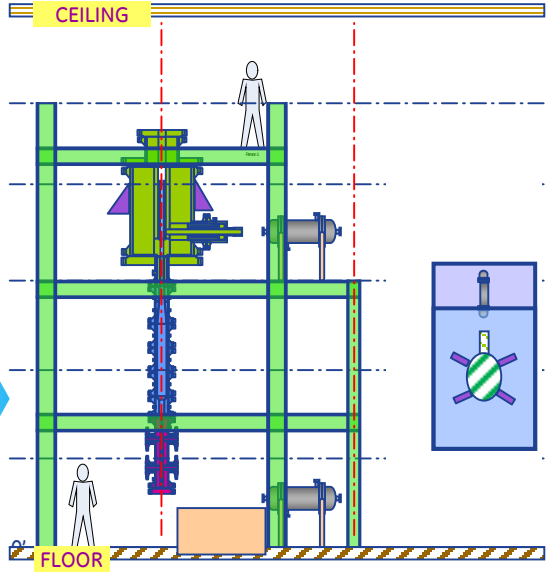


Real Time Testing

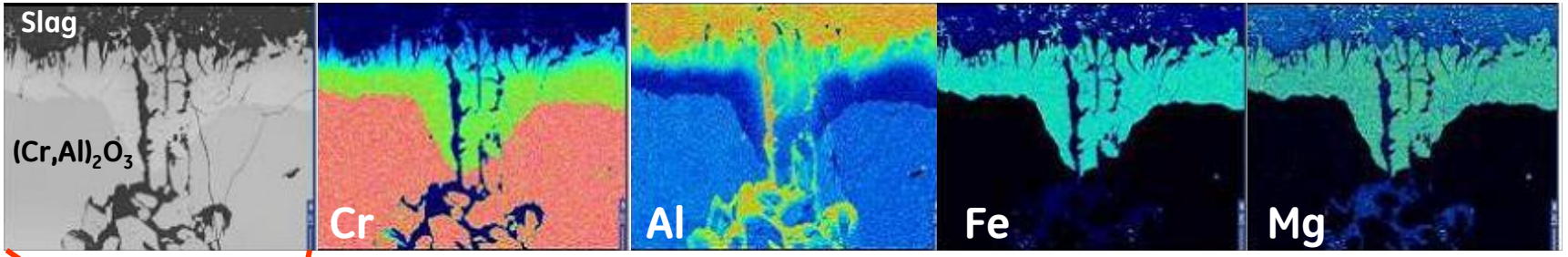
- Distributed flow and temperature data
- Start up and shut down data for transients
- Corrosion testing for materials and fabrication
- Deposit sampling

Drop Tube Furnace

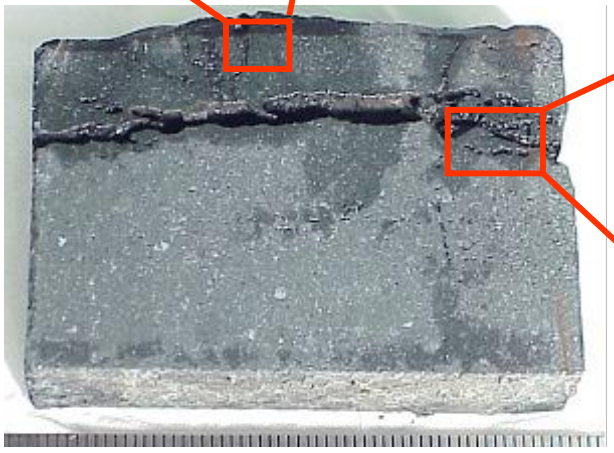
- Full pressure/ temperature to simulate Ref Plant
- Ability to run different feedstock
- Materials testing



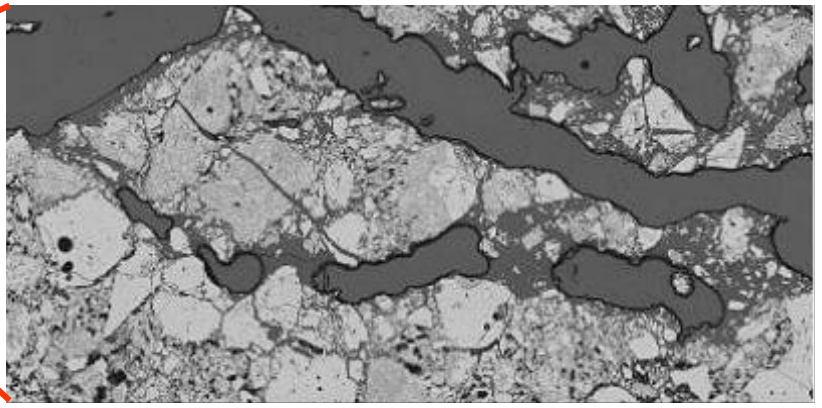
Refractory Life Extension Program



Chemical mapping reveals interaction between slag and refractory surface



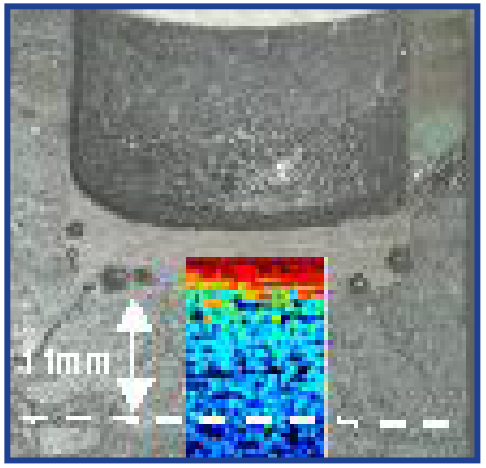
Solids Gasifier Refractory Brick

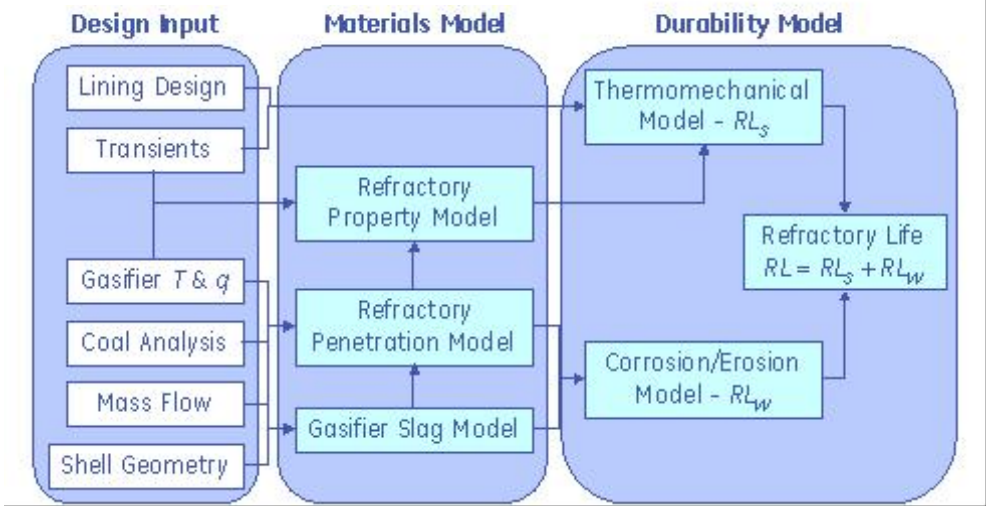


Slag penetrates the grain boundaries within the refractory brick

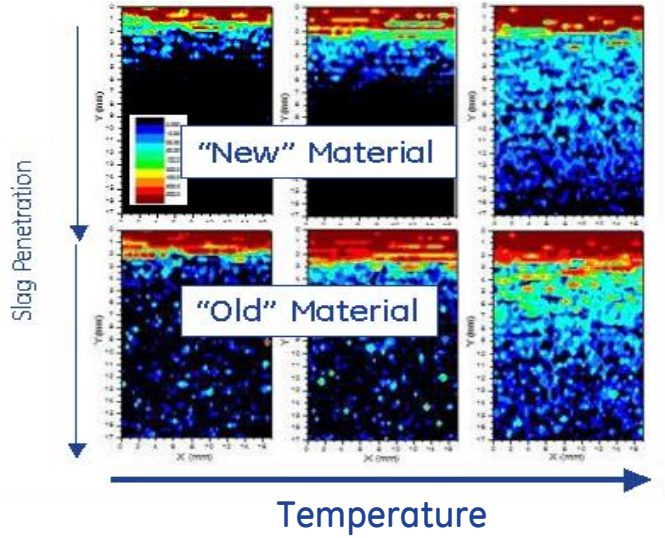
Identifying/understanding failure mechanisms

Refractory Reliability Model





- Understand Failure Mechanisms
  - Corrosion/Erosion
  - Thermo mechanical forces
- Focus programs to mitigate failures
- Match interval w/major GT outage



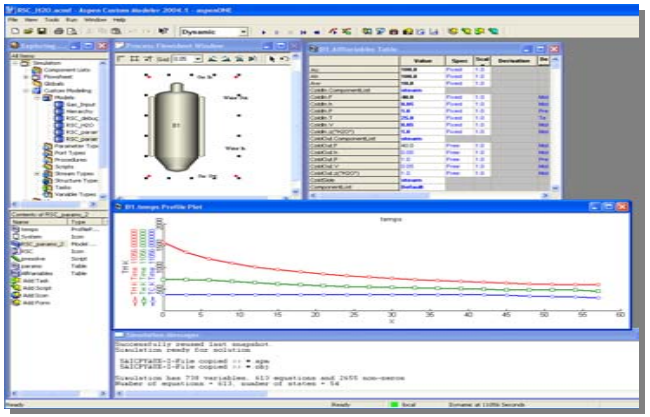
Engineering Simulation/Operator Training

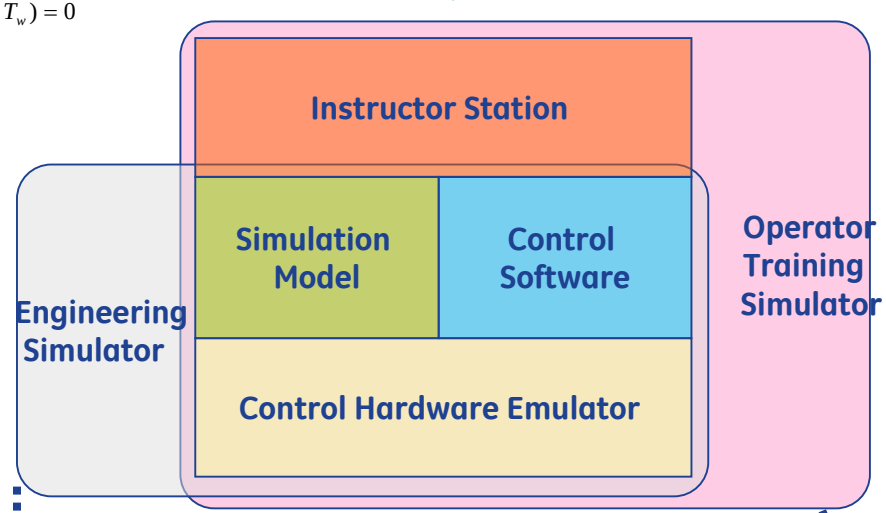
$$\rho_h A c_p \frac{\partial T_h}{\partial t} + \vec{\upsilon}_h c_p \frac{\partial T_h}{\partial x} - \kappa_h A \frac{\partial^2 T_h}{\partial x^2} + U_h A(T_h - T_w) + \sigma \varepsilon A(T_h^4 - T_w^4) = 0$$

$$\rho_w A c_p \frac{\partial T_w}{\partial t} - \kappa_w A \frac{\partial^2 T_w}{\partial x^2} + U_h A(T_w - T_h) + U_c A(T_w - T_c) = 0$$

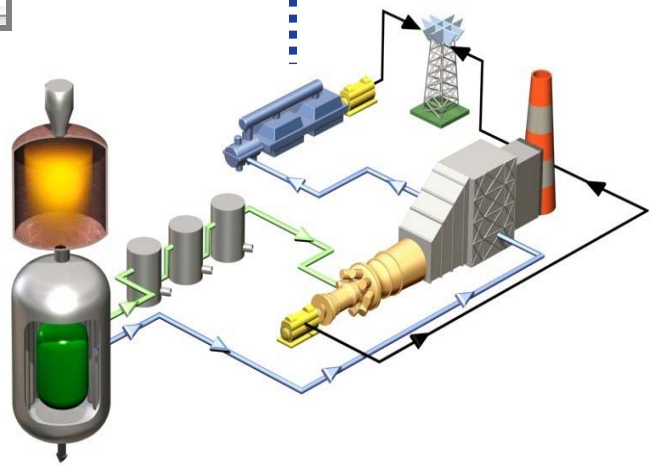
$$\rho_c A \frac{\partial H_h}{\partial t} + \vec{\upsilon} \frac{\partial H_h}{\partial x} - \frac{\kappa_c A}{c_p} \frac{\partial^2 H_h}{\partial x^2} + U_c A(T_c - T_w) = 0$$

Engineering Class Simulation for Controls Operability & Operator Training





Generate Physics Based Transient Equipment Models



imagination at work

Summary

- Plant Level Technology Needs Driving Program Selection
- NPI Processes in Place to Assure Consistency and Technical Rigor
- Understand Physics
- Leverage Broad Teams and Tools
- Validate