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Refractory Engineering & Technical Services

A&A Gasification Seminar
April 11, 2017

Wade Taber

About Me

Over 25 years of Refractory & Gasification experience…

QCR	Quad City Refractories	1990 - 1996	Refractory Journeyman
ZAMPELL	Zampell Refractories	1997 - 1998	Construction Supervisor
SAINT-GOBAIN	Saint-Gobain Ceramics	1998 - 2007	Sr. Application Engineer
GE	GE Gasification	2007 - 2016	Engineering Manager
SES SYNTHESIS ENERGY SYSTEMS	Synthesis Energy Systems	2016 - Present	Vice President Engineering

…available for Refractory and Related Process Support

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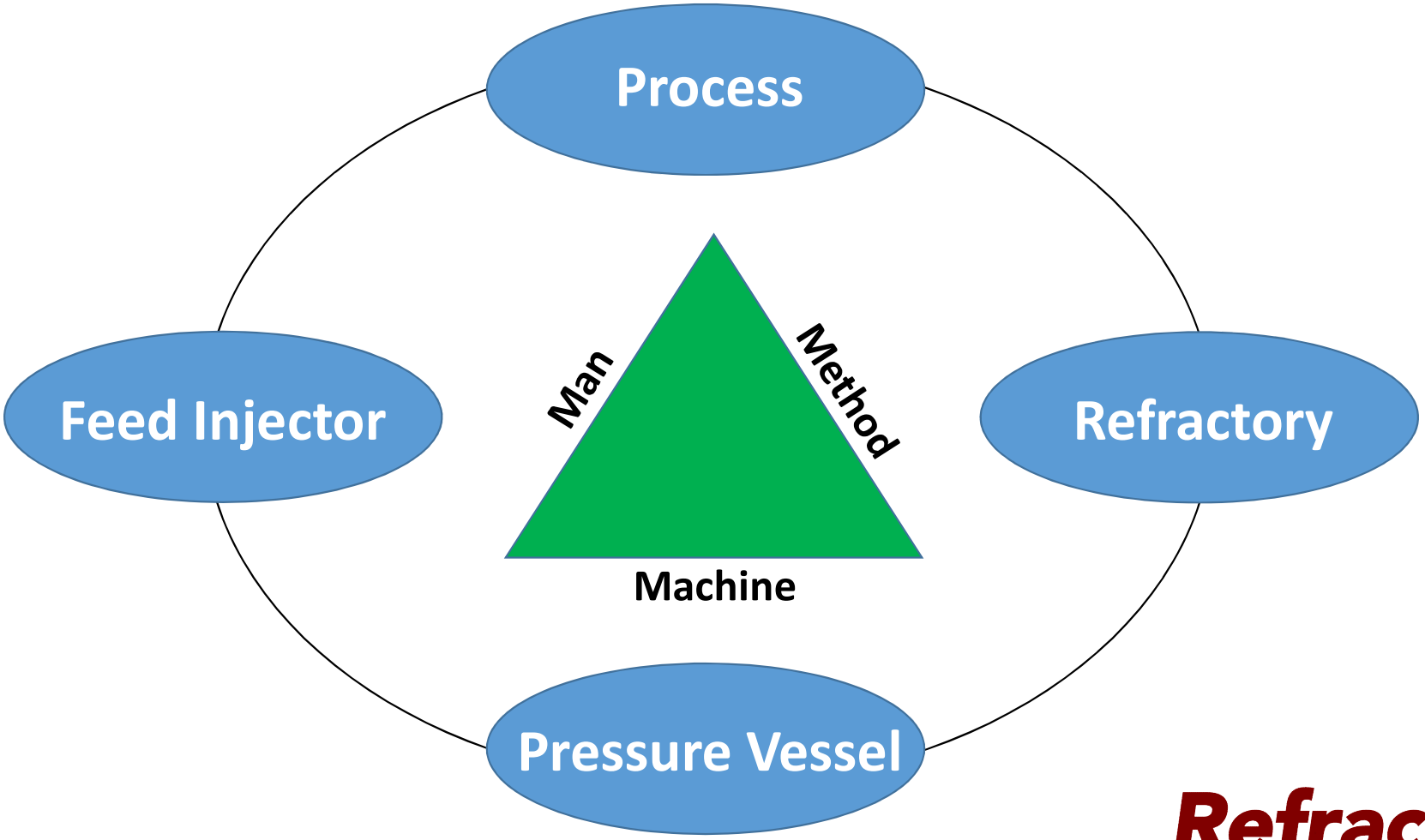
Holistic Approach to Design & Problem Solving



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Gasification Process Fundamentals

Gasification		versus		Combustion
CO	←	C	→	CO_2
H_2	←	H	→	H_2O
N_2	←	N	→	NO_x
H_2S	←	S	→	SO_x
	←	O	→	O_2

Source: NETL Gasification Website www.netl.doe.gov

$C + ½ O_2 \rightarrow CO$ (-111 MJ/kmol)

$CO + ½ O_2 \rightarrow CO_2$ (-283 MJ/kmol)

$H_2 + ½ O_2 \rightarrow H_2O$ (-242 MJ/kmol)

$C + H_2O \leftrightarrow CO + H_2$ (+131 MJ/kmol)

$C + CO_2 \leftrightarrow 2CO$ (+172 MJ/kmol)

$C + 2H_2 \leftrightarrow CH_4$ (-75 MJ/kmol)

$CO + H_2O \leftrightarrow CO_2 + H_2$ (-41 MJ/kmol)

$CH_4 + H_2O \leftrightarrow CO_2 + 3\ H_2$ (+206 MJ/kmol)

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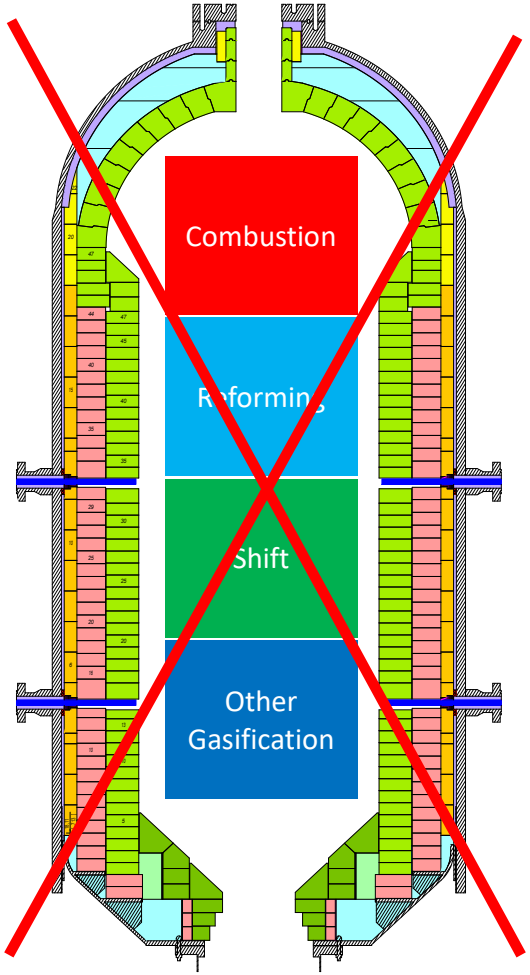
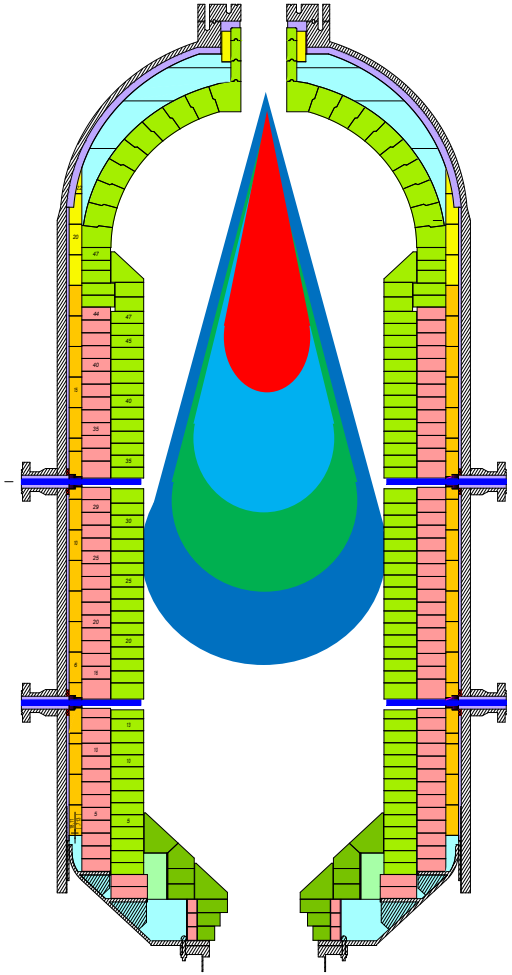
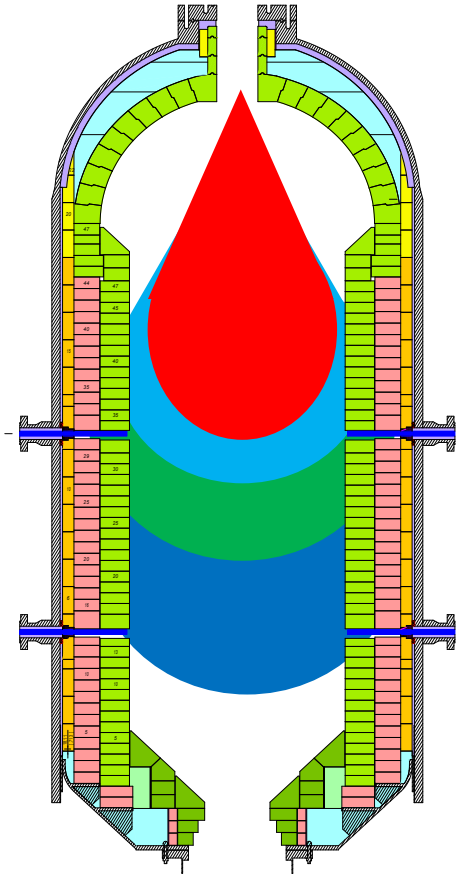
Gasification Process - Practical Thermodynamics







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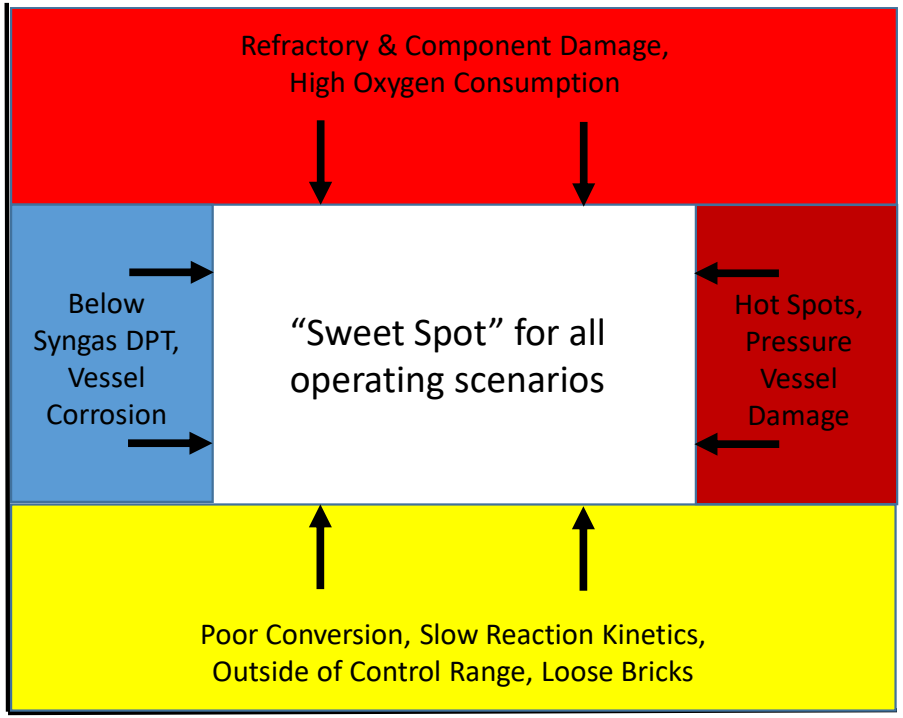
Thermal Design of Gasification System



Influencing Factors:

- PV Design Limits
- PV Thickness, Condition
- Feedstock Requirements
- Process Rates, SOC/SCC
- Process Variations
- Ash Melting Temperature
- Ambient Seasonal Changes
- External Wind Speed
- Lining Geometry
- Material Deviations

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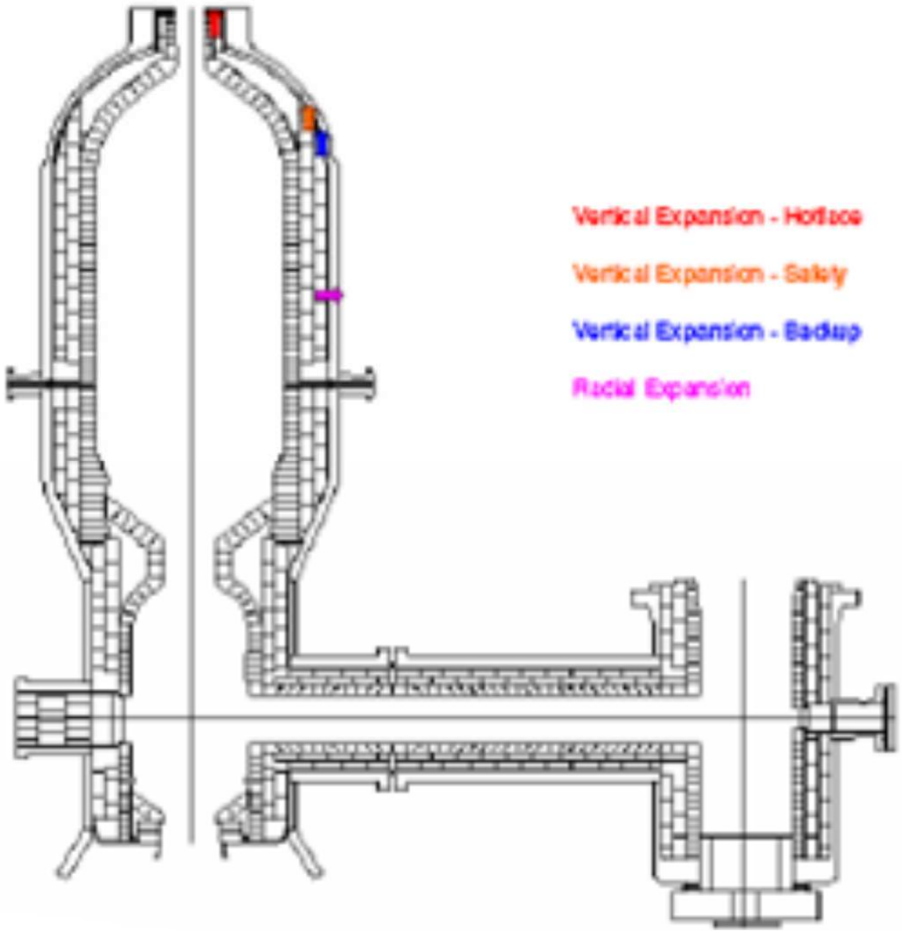
Mechanical Design of Gasification System



Design Concerns:

- Mechanical loading on support shelves
  - Constrained shelves
- Differential Thermal Expansion
  - Vessel & Refractory
  - Refractory Layers
  - Dome Hotface & Castable
- Expansion Joints
  - Compression & Insulation
  - Open Joints
- Pressure Vessel Integrity
- Flanged Connections
- WHB Tubesheet

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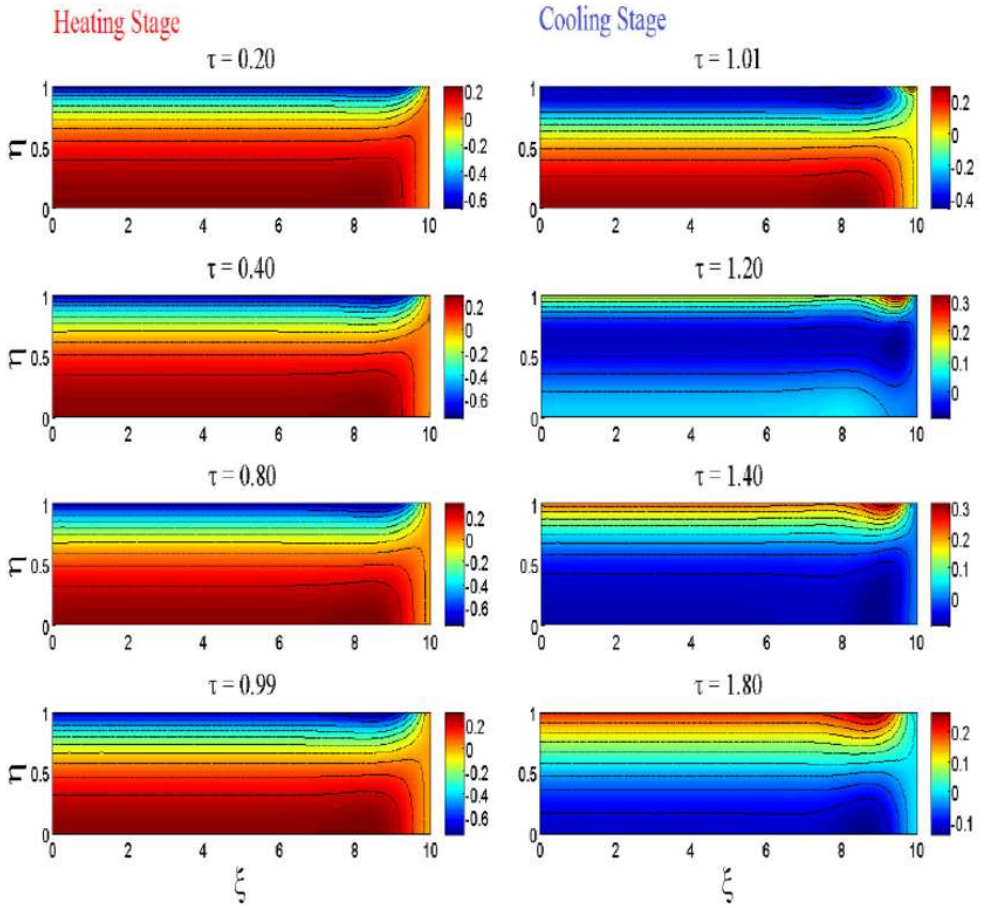
Thermomechanical Stress

- Refractories have high compressive strength, but are weak in tension
- Consider transient effects
- Stress is additive
- Thermal shock is bad
- Microstructure matters



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Feed Injector Issues

- Tip velocity design criteria
  - Gas mixing
  - Spray angle
  - Thermal load on face, flame anchoring
  - Thermal expansion
  - Feed & Process dependent
- Concentricity & Uniformity
- Corrosion Issues
- Oxygen Flammability
- Life & Repair

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Best Practices

- Limit Forced Outages through Mechanical Integrity Programs & Operator Training
- Knowledge Transfer, Continuous Improvement through Learning
- Deep understanding of Cause & Effect – utilize technology providers and experts

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RefracTech Services Offered

- Refractory Design Packages – New Linings, Improvements and Modifications
- Advanced Thermal and Mechanical Calculations – Steady State and Transient
- Work Scope Planning and Inventory Management Support
- Vendor Quality Control
- Lining Inspections and Reports
- Construction Supervision and Logs
- Third Party Materials Testing
- Thermography & Dimensional Scanning - with Findings and Analyses
- Process Support and Data Analytics
- Subject Matter Expertise – Training and Consulting
- Current Safety Certifications
- Online Collaboration and Data Tools

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THANKS

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