Modular Staged OMB Gasification Technology (DE-FE00031506)

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Project Overview

- **Project Title:** Staged OMB for Modular Gasifier/Burner
- **Project Start Date:** December 1, 2017
- **Scheduled Duration:** 3 years
- **Two Budget Period:** $2,500,482
- **Project Partners:**
  - East China University of S&T
  - Trimeric

Budget Period	Performing Organization	Planned Costs		
		Federal Share	Non-Federal Share	Total
1	UKRF	$1,415,308	$385,884	$1,801,192
1	ECUST	$72,000	$18,000	$90,000
1	Trimeric	$125,000	$0	$125,000

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ECUST

Trimeric Corp.

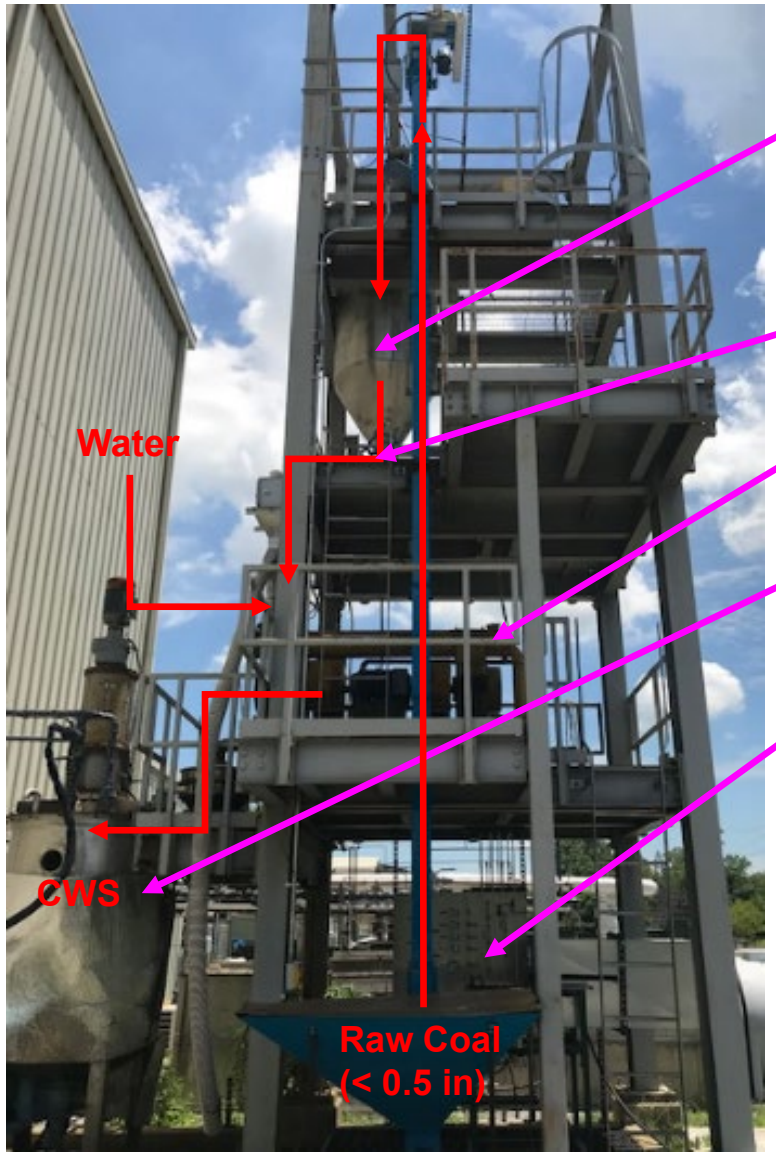
Project Objectives & Task List

Objective:

- Modularize gasifier and standardize the burner design with a focus on modularization.
- Investigate the effect of water quench on gas composition, such as the increase in H_2 due to the water gas shift (WGS) reaction.
- Modify UK CAER's 1 TPD coal OMB gasifier to form a staged gasification simply by replacing the existing camera monitor with a burner at the top of the gasifier.

- **Task 1:** Project Management and Planning
- **Task 2:** Construction of the Staged-OMB Gasifier
- **Task 3:** Parametric Study of Staged-OMB
- **Task 4:** Fuel Flexibility with Fuel Blend
- **Task 5:** In-situ Water Gas Shift (WGS) Development
- **Task 6:** Burner Testing
- **Task 7:** 3-D Simulation of Staged-OMB Gasifier and Burner Effect
- **Task 8:** Technical and Economic Analysis

CWS Preparation



Ability to test different coals & CWS properties

- Gibson Coal
- River View Coal
- Powder River Basin Coal

- Additives
- Particle size
- Desired slurry characteristics

Typical Properties of CWS

Average particle size (μm)	Mass concentration	Viscosity (mPa·s)
<50	<60%	<250

Opposed Multi-burner Gasification

Provides Flexibility for:

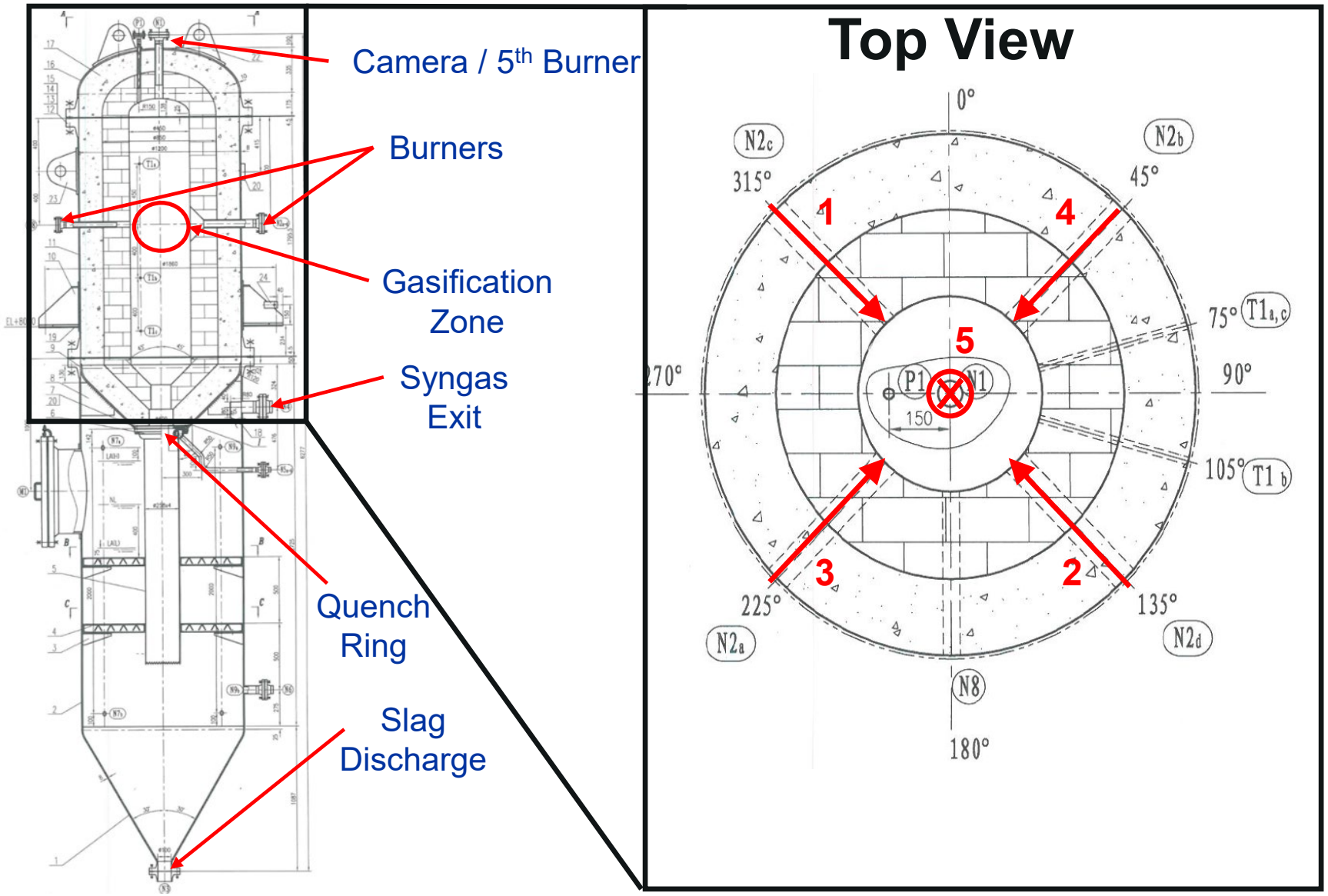
- Gasification
- Downstream Utilization

- Highly Load Flexible (20%-150%)
  - Slurry pumps scale capacity using frequency controller
  - Number of active burners can be increased or decreased

- Variety of Feedstocks

- Co-feed Capability (Coal and Natural Gas)

Staged Opposed Multi-burner Gasifier



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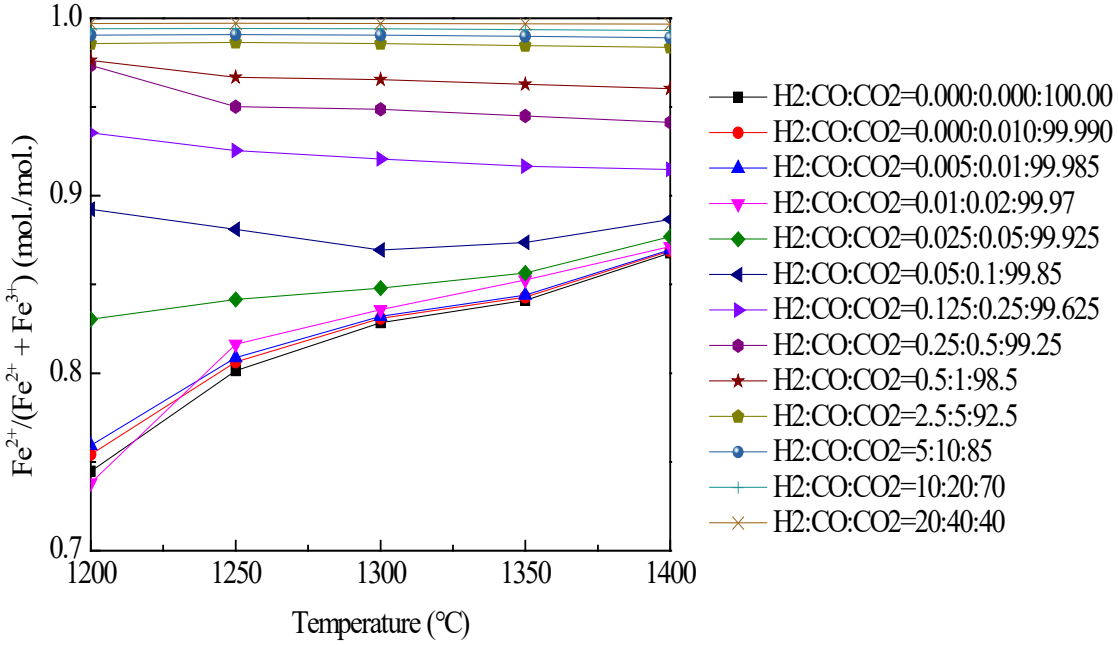
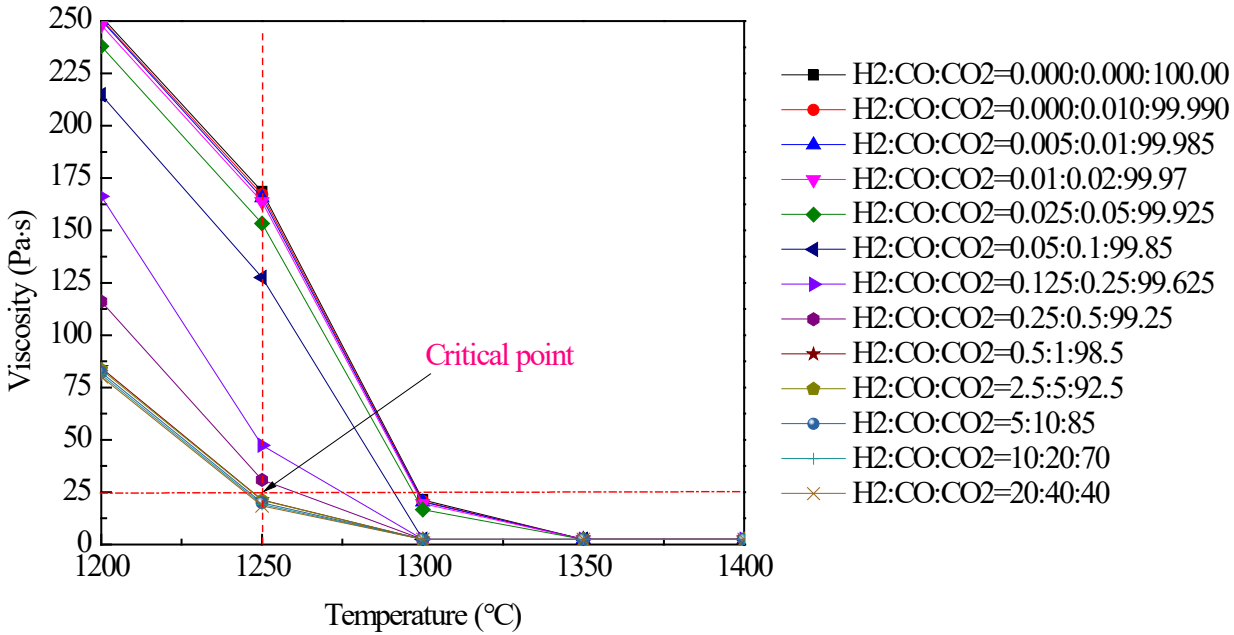
Gasifier Heating & Operating Critical Atmosphere Prediction

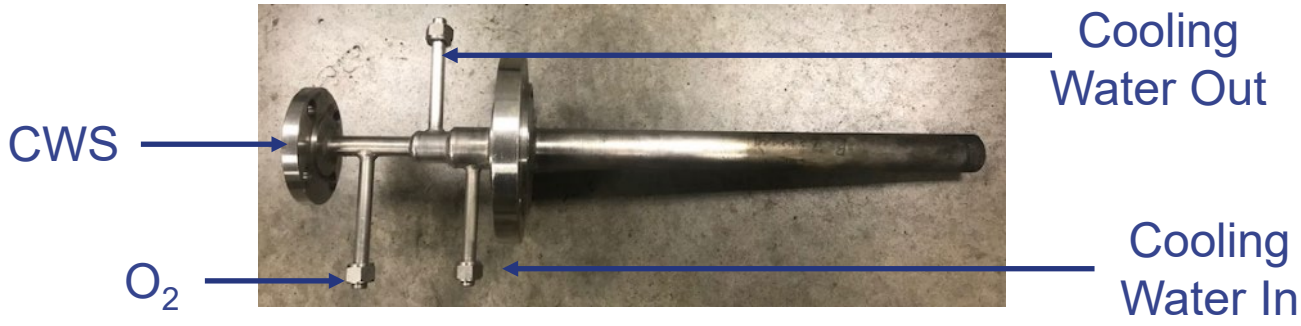


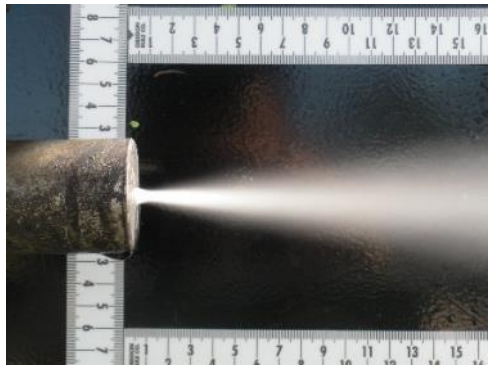
- Syngas content (H_2+CO) needs to be higher than 7.5 vol % and the viscosity of the slag at 1250 ℃ will be lower than 25 Pa s.

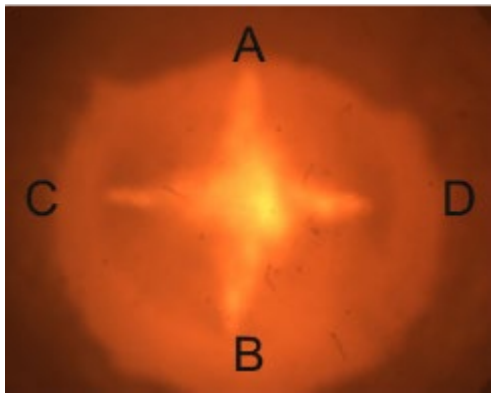
- With lower syngas content (H_2+CO), more Fe^{3+} is formed, especially when the temperature is below 1250 ℃
- The content of H_2+CO should be higher than 7.5 vol % so that there will be less Fe^{3+} in the slag.



Burner Modification and Testing







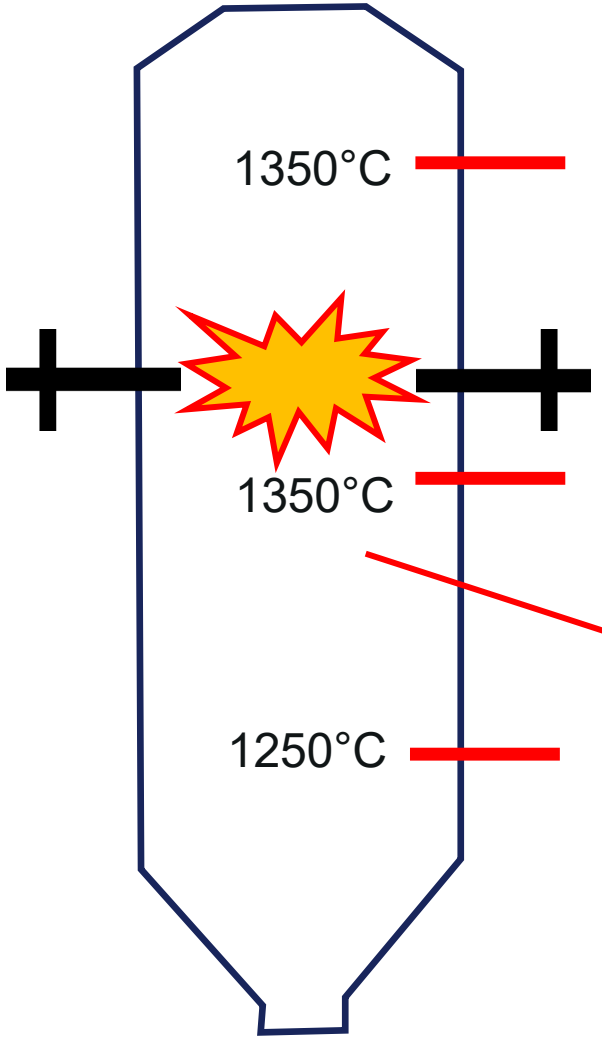
Burner Test Stand
- Jig for burner installation
- Atomization testing
- Burner evaluation

Commercial Velocity
- 100-120 m/s

Project Updates/Accomplishments Summaries

- Project Results from Various Loads, Coals and Burner Automization
  - Stable operation with the loads from 25% - 125 %
  - Fuel flexibility with chemical additive to modify the slag temperature
  - CFD, temperature and gas composition
  - PFD and Process simulation for TEA

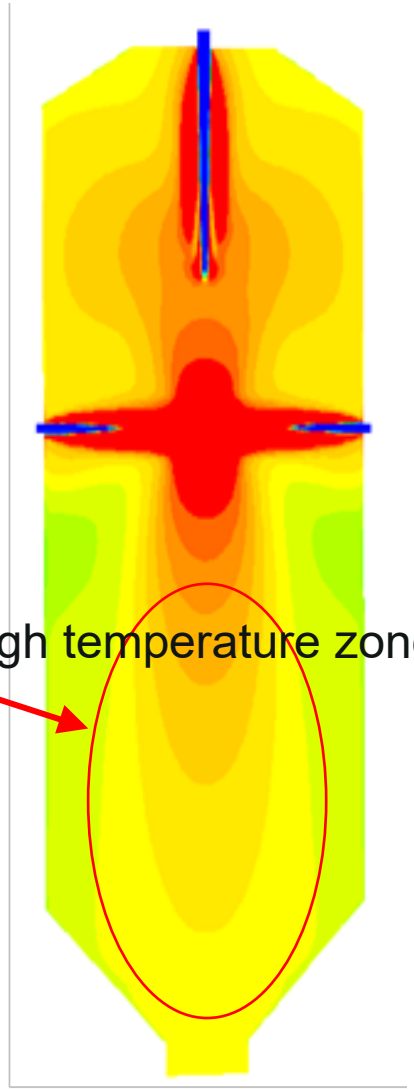
CWS Preparation and Treatment

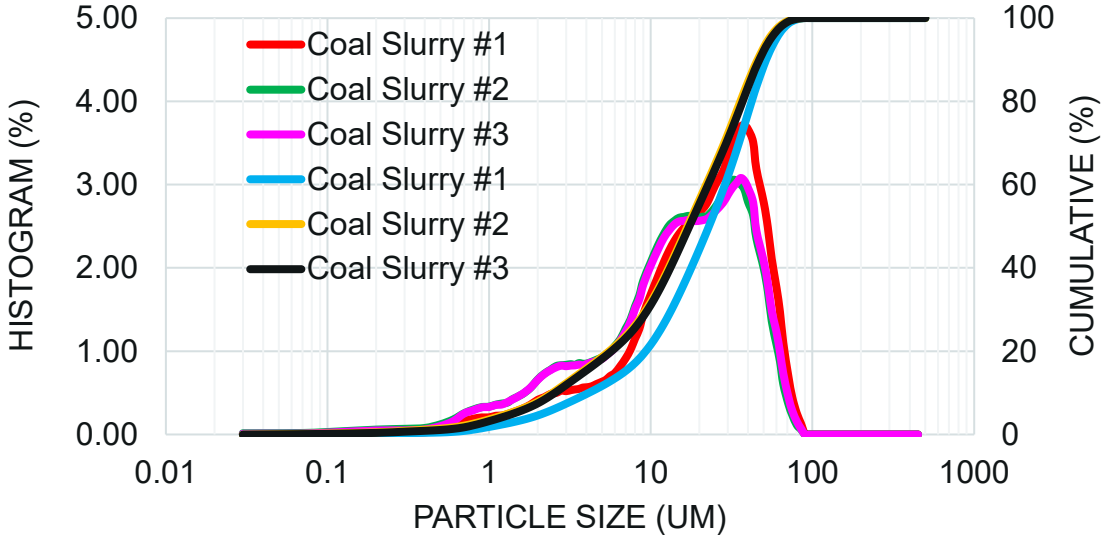


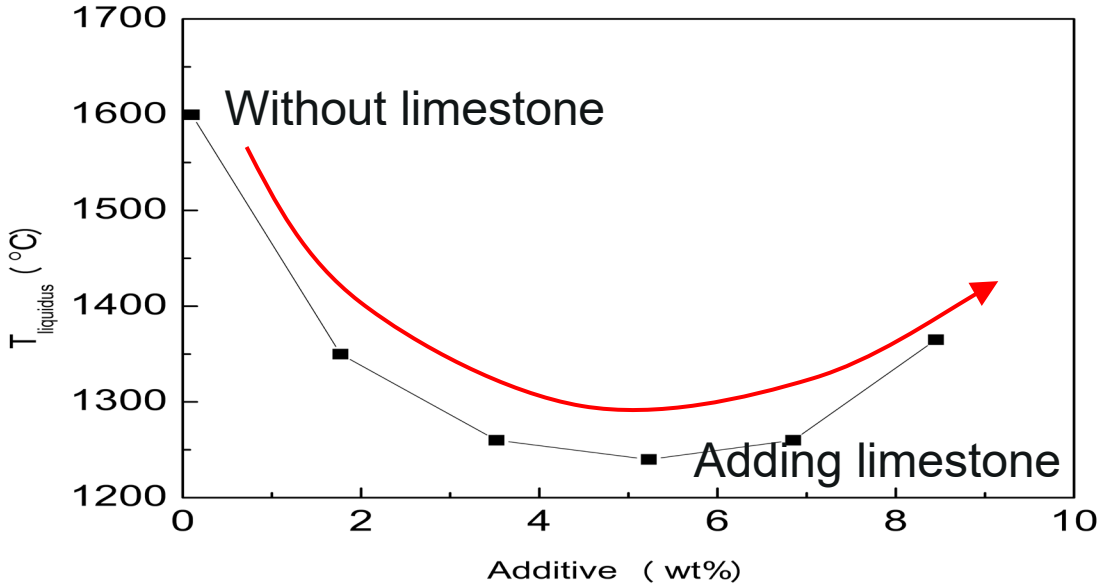
TC-1

TC-2

TC-3

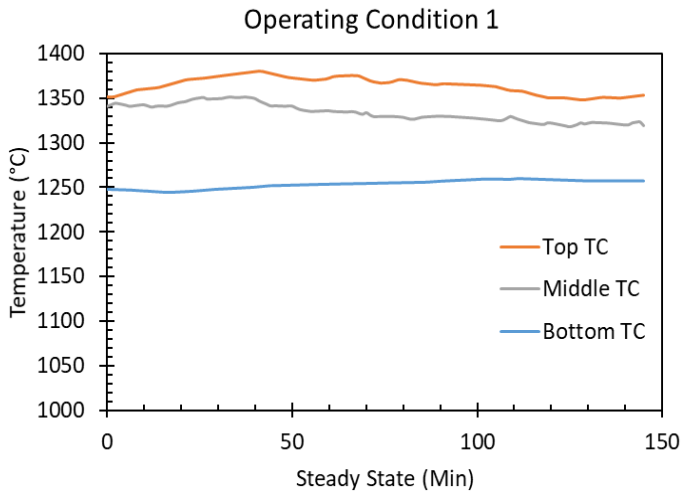


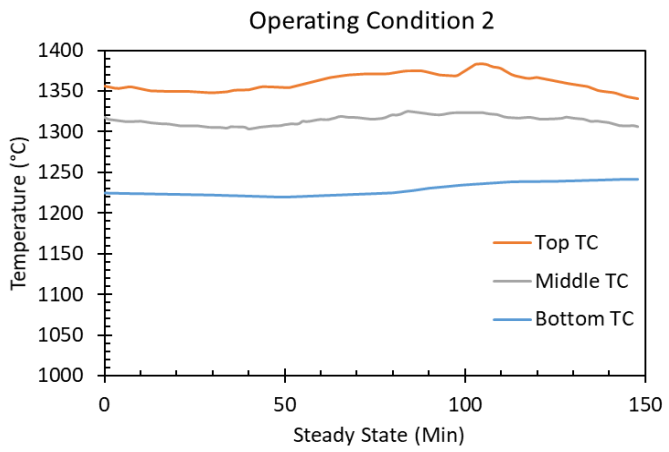


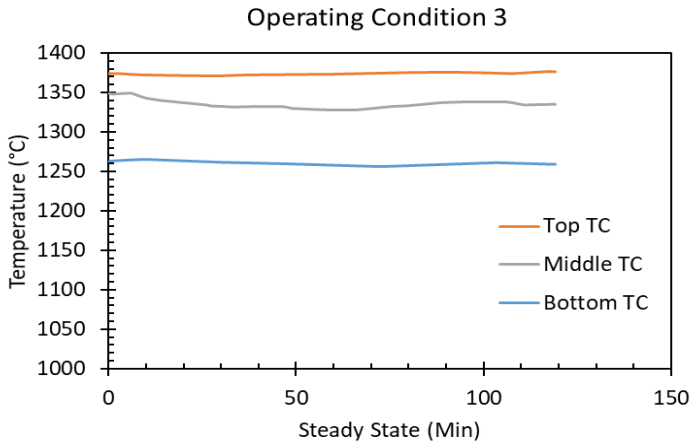


Gasification with Various Loading

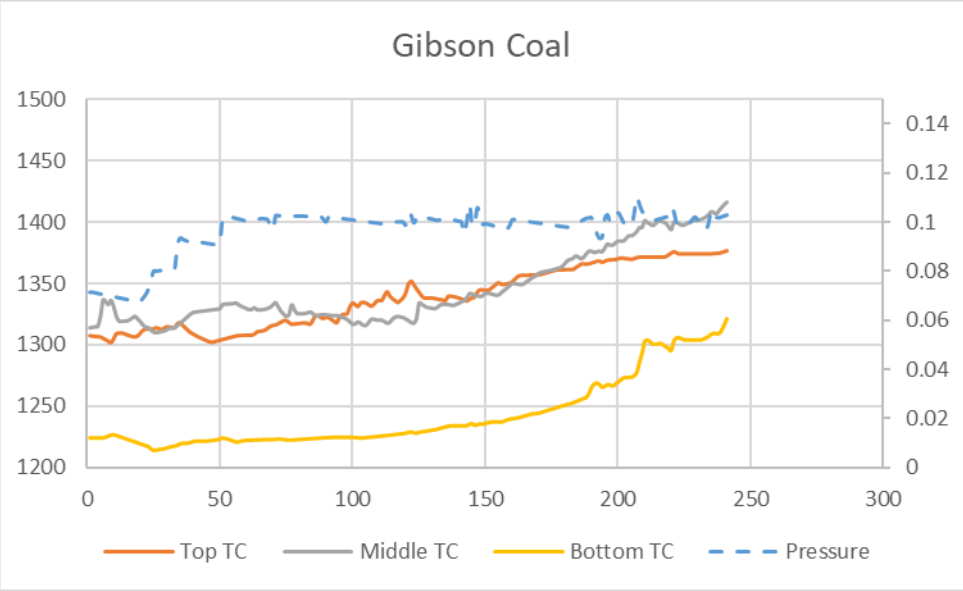
Operating Condition	1	2	3	4
Coal	RV	RV	RV	RV
Setting Temperature (°C)	1350	1300	1350	1350
Pressure (MPaG)	0.1	0.1	0.1	0.1
CWS solid (wt.%)	57	57	57	57
Additive (Coal-based wt.%)	0.3	0.3	0.3	0.3
Limestone (Coal-based wt.%)	1	1	1	1
O/C atomic ratio	1.19:1	1.19:1	1.15:1	1.12:1
CWS burners in service (#)	3	3	1	1
NG burner in service (#)	0	0	2	2
Heat value ratio (NG% : Coal%)	0:100	0:100	22:78	19:81

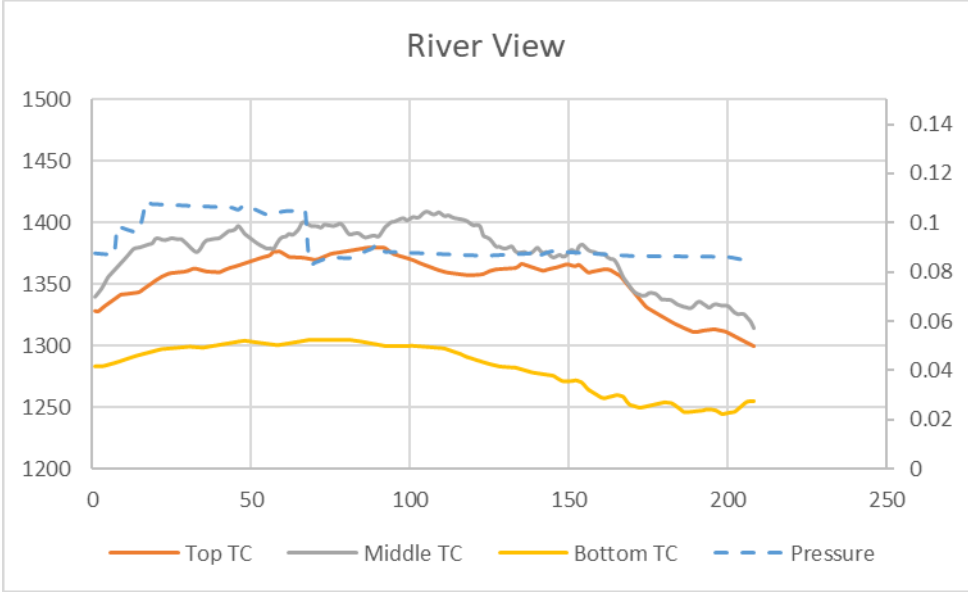


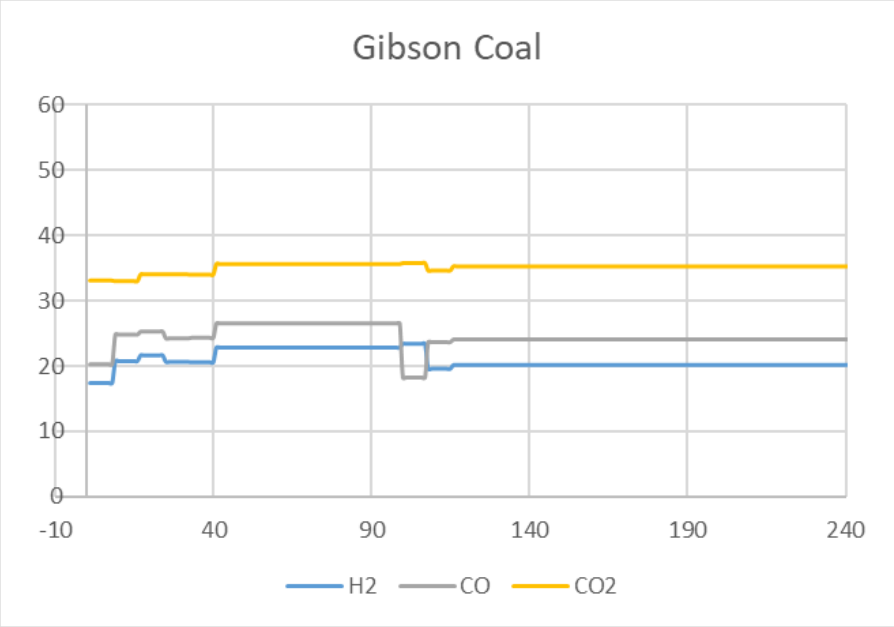


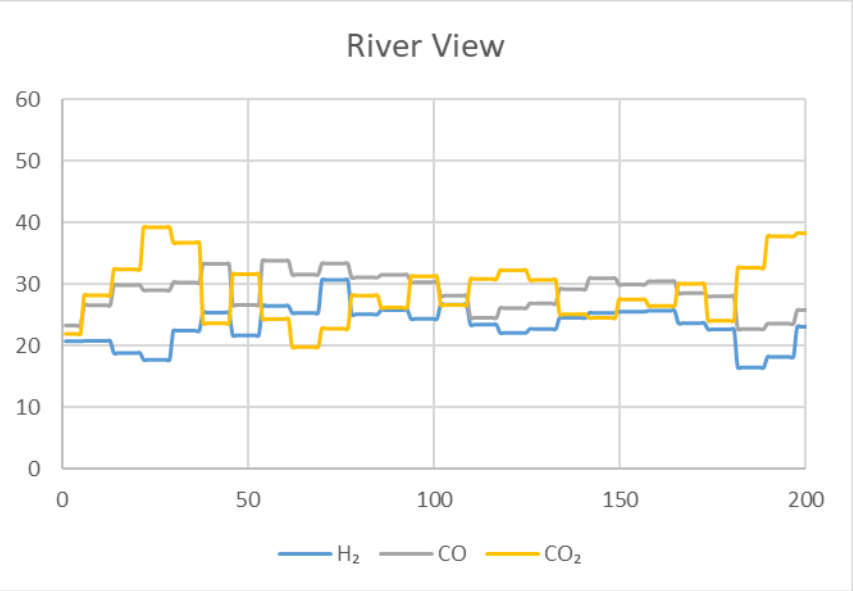


Gasification with Various Coals









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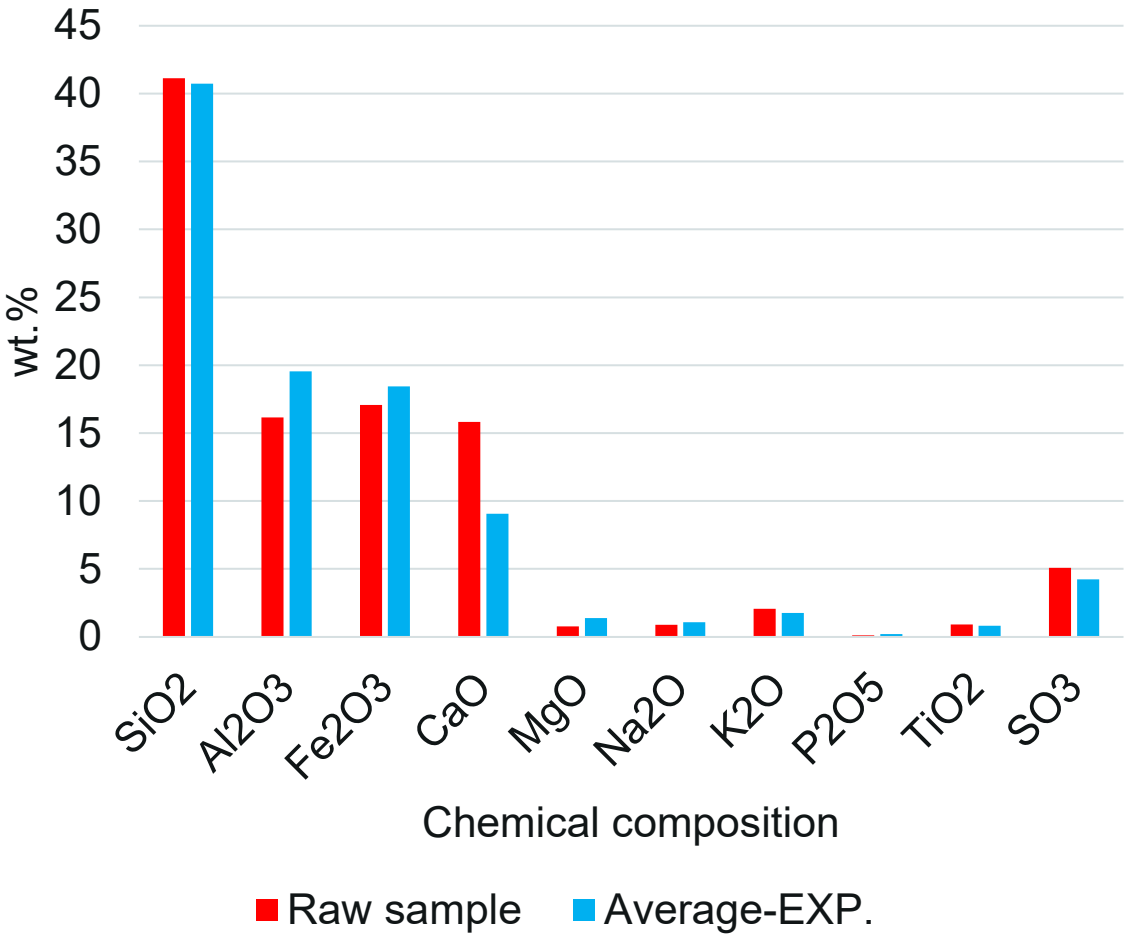
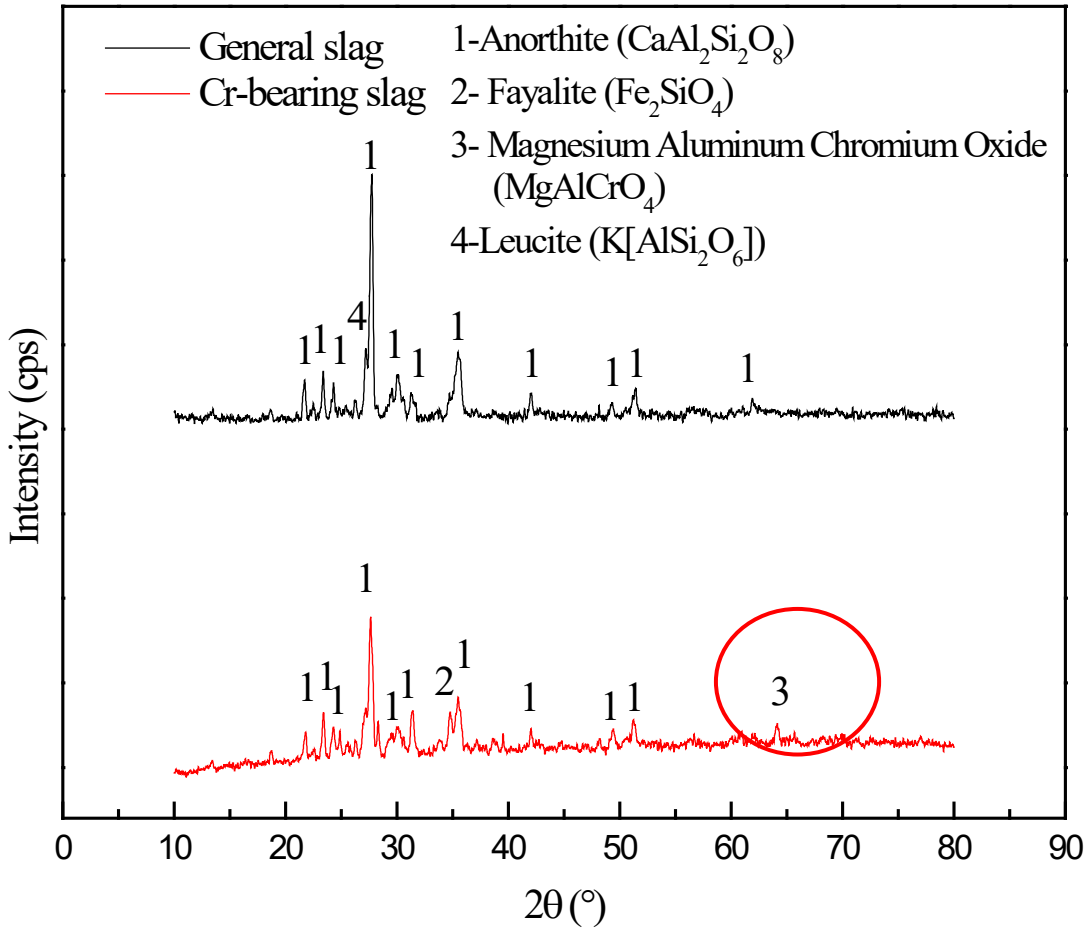
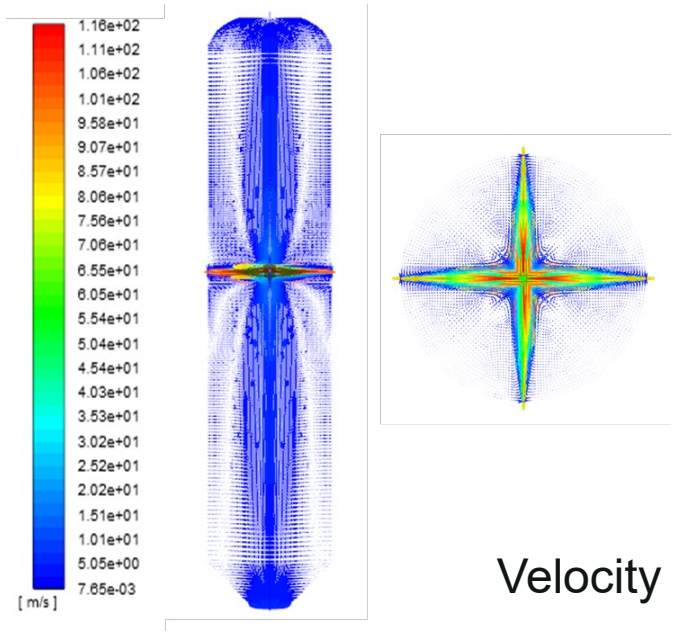
Chemical Composition of Slags



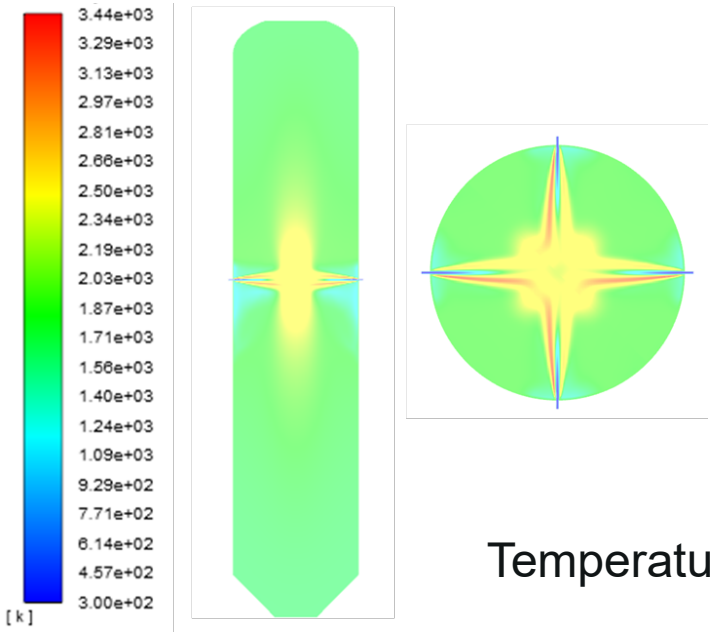


- Collected slag sample from the gasifier shows lower Ca content compared to the mixed coal ash sample
- With mortar on the refractory, Cr would merge into the coal slag and change the mineral type in comparison with general slag

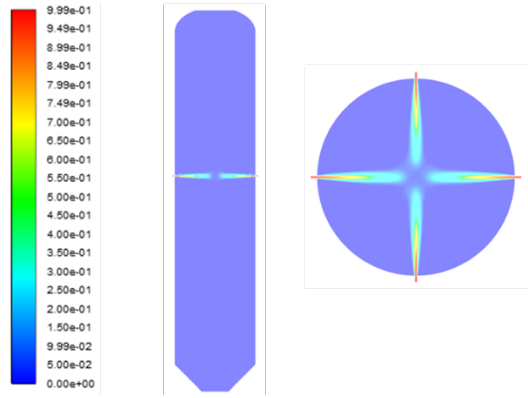
CFD Modeling



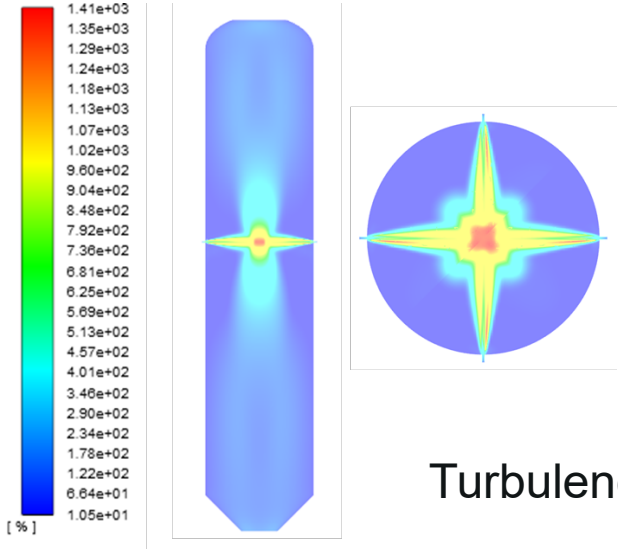
Velocity



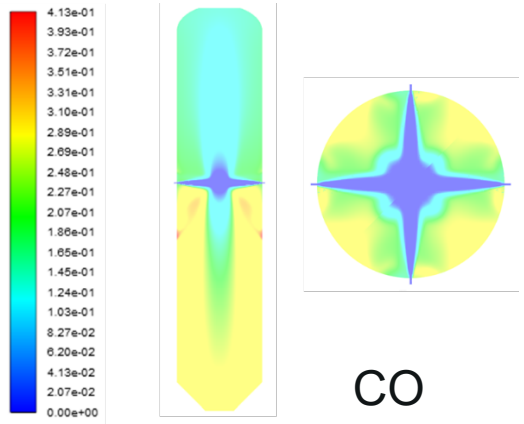
Temperature



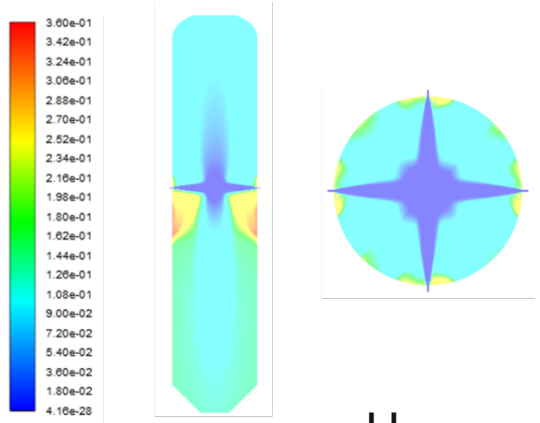
O_2



Turbulence



CO



H_2

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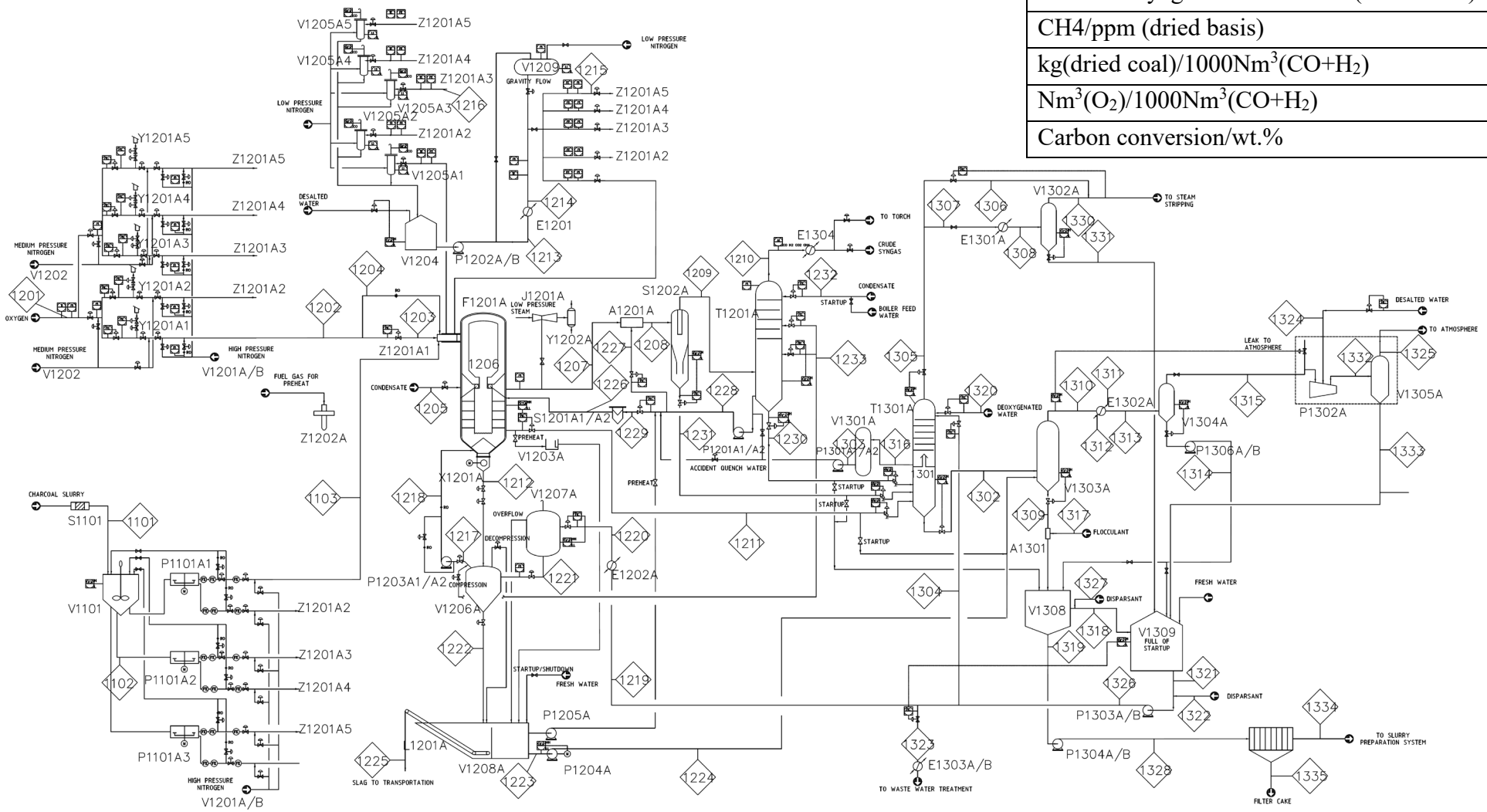
PFD and Process Simulation

Gasification pressure/MPa(G)	2.0
Gasification temperature/℃	1300
Effective syngas content/vol.% (dried basis)	80.80
CH4/ppm (dried basis)	481.41
kg(dried coal)/1000Nm^3(CO+H$_2$)	587.53
Nm^3(O$_2$)/1000Nm^3(CO+H$_2$)	394.41
Carbon conversion/wt.%	98.00



Conclusions

- Highly Load Flexible testing (25%-125%) of the Staged OMB gasification is completed.
- The proposed OMB is coal-flexible .
- Coal ash fusibility are predicted via experimental and modeling method.
- Experimental data confirmed the CFD
- PFD and process simulation complete and TEA is under way.

Acknowledgements

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