Staged-OMB for Modularized Gasifier

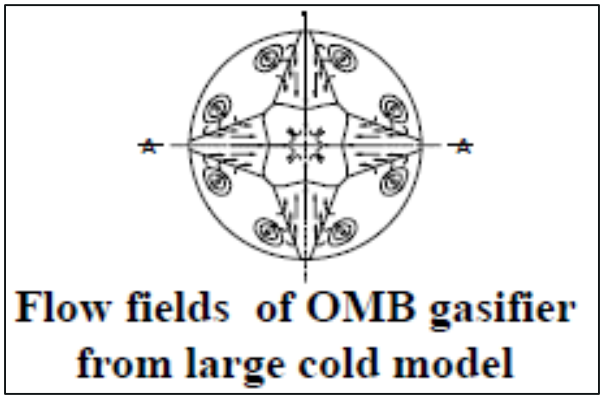
DE-FE0031506

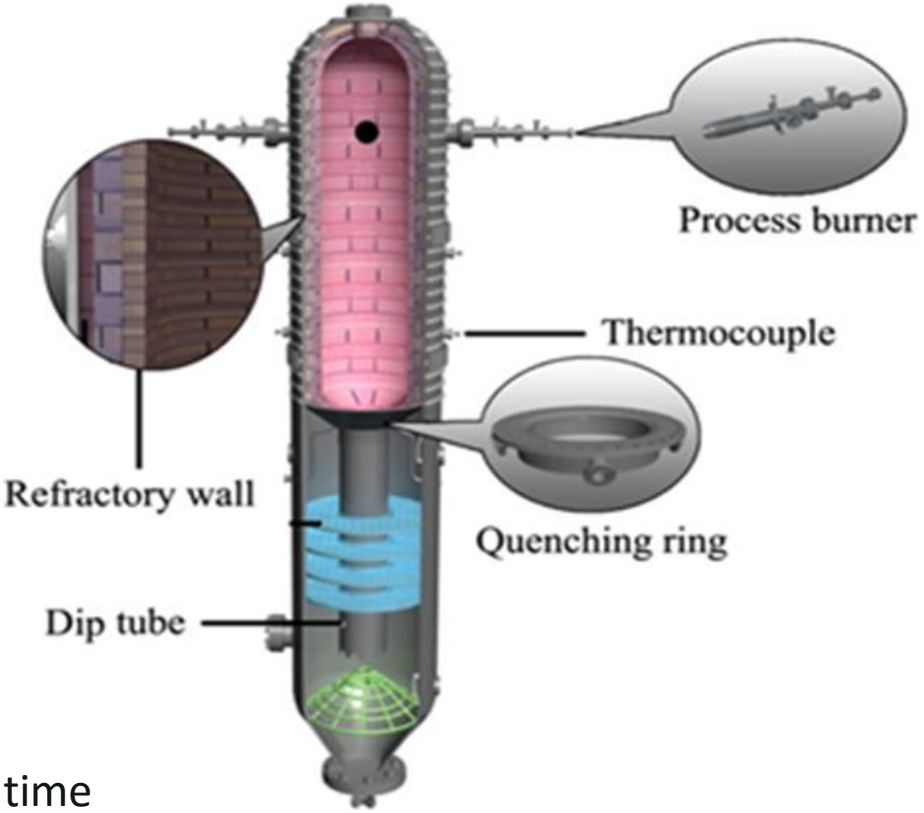
University of Kentucky, Center for Applied Energy Research
http://www.caer.uky.edu/powergen/home.shtml

Overview

- Background
- Project objective(s)
- Technical approach
- Project structure
- Project schedule
- Project budget
- Project Management Plan

Background – OMB Technology

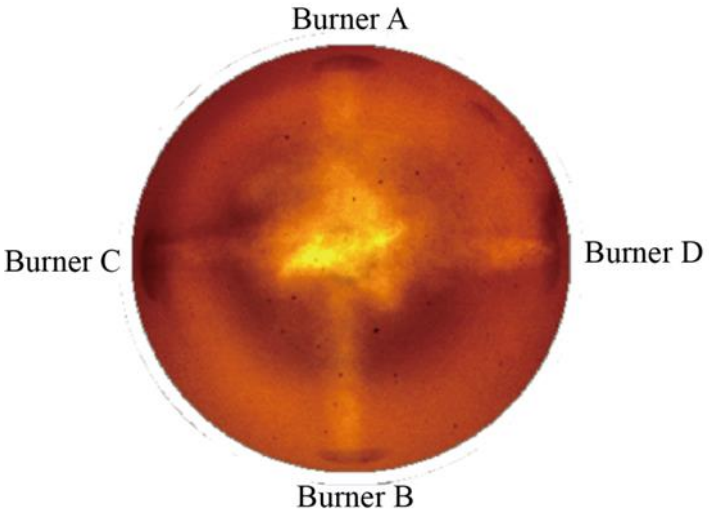

Flow fields of OMB gasifier from large cold model



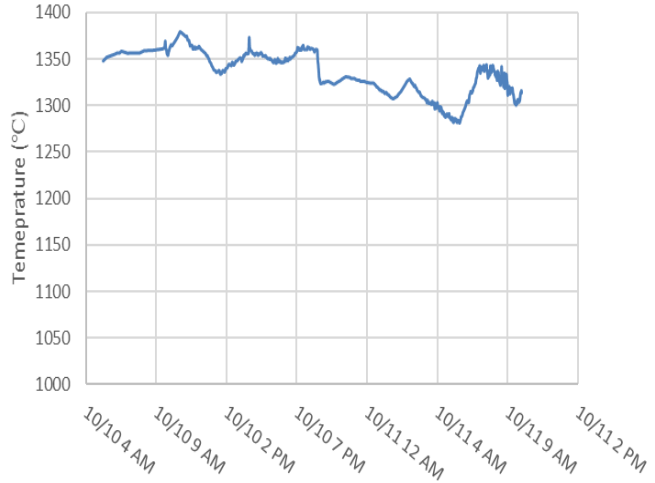
- Flow pattern and residence time distribution of fuel are relatively independent of the gasifier size
- Size-independent horizontal flow pattern and droplet size especially suitable for small-scale modular application

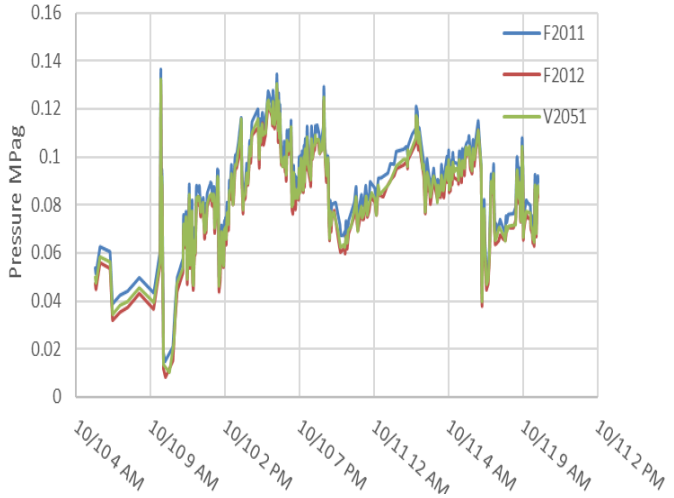
- Scale-up demonstrated
- Small scale for fuel flexibility study needed

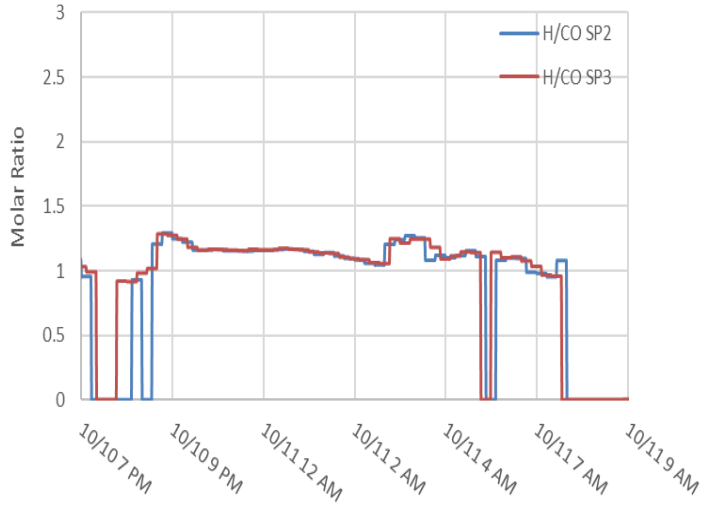
Background – CAER 1 TPD Unit



Background – Operation Data for CAER Unit





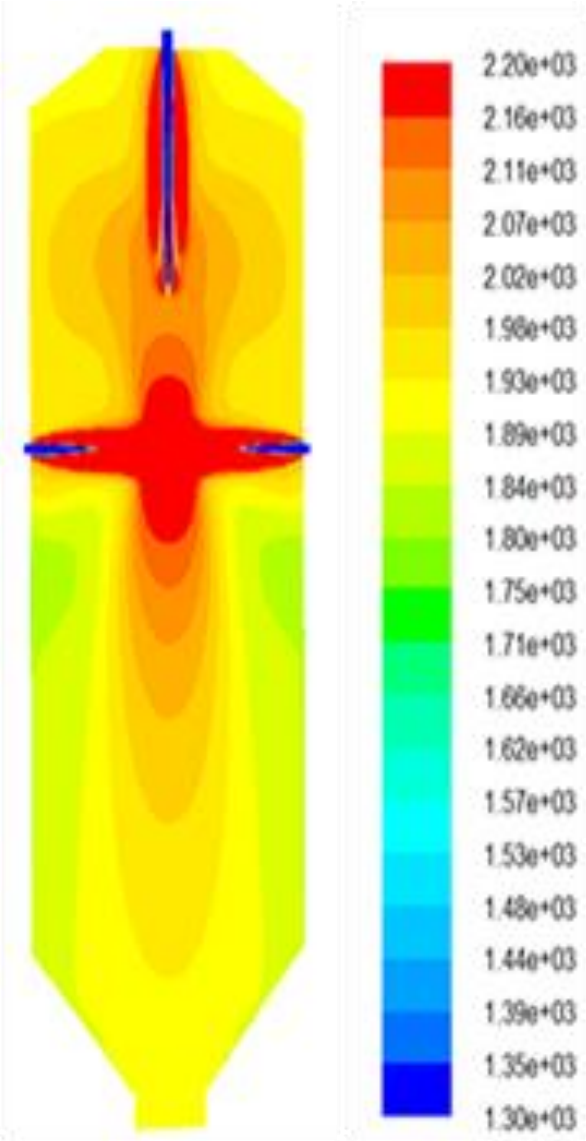


- Operationally stable for entire testing run
- H_2/CO ratio ~ 0.7-1.1

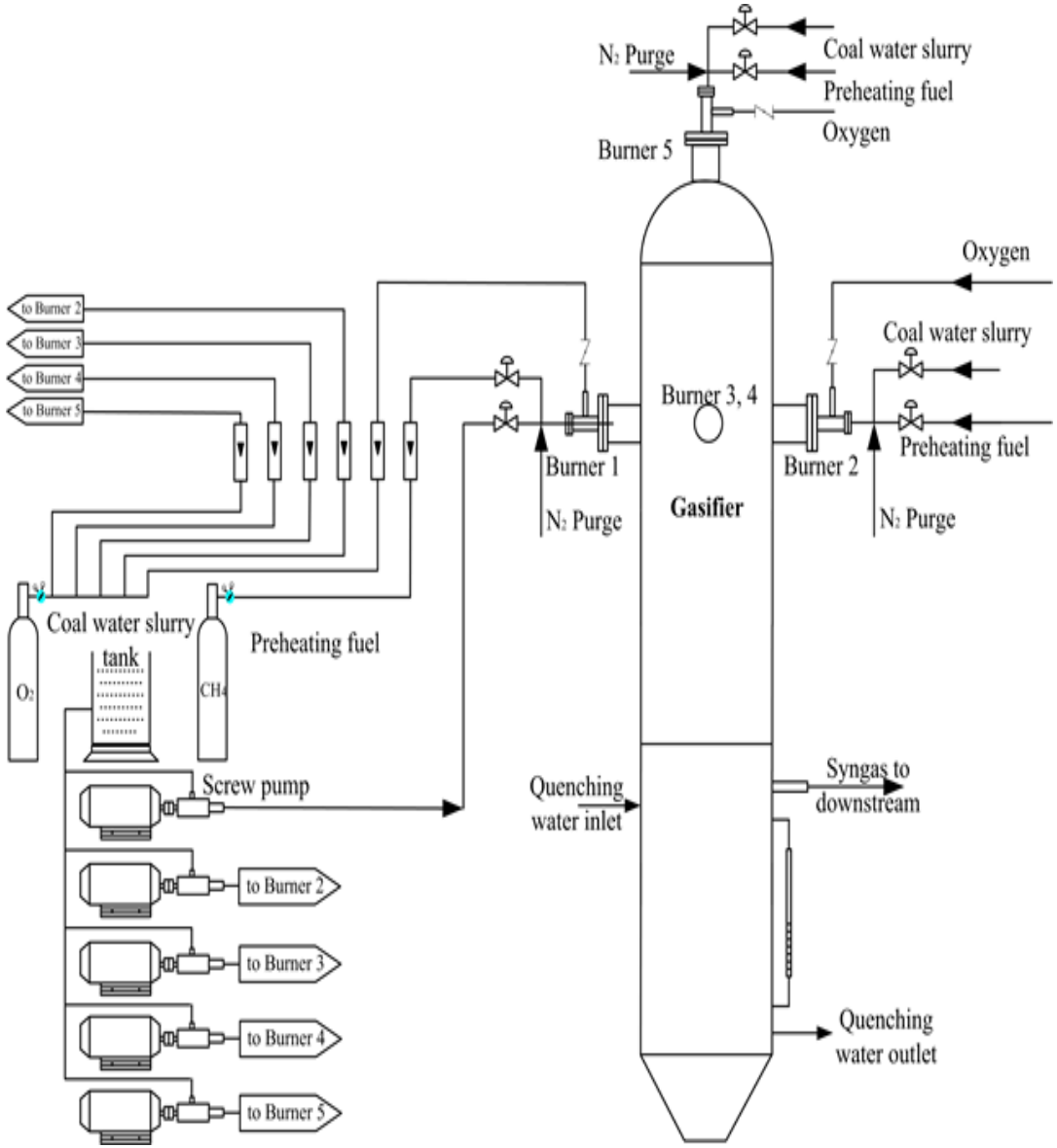
- 24 hour data period
- Generally operate 1 week at a time

Project Objectives

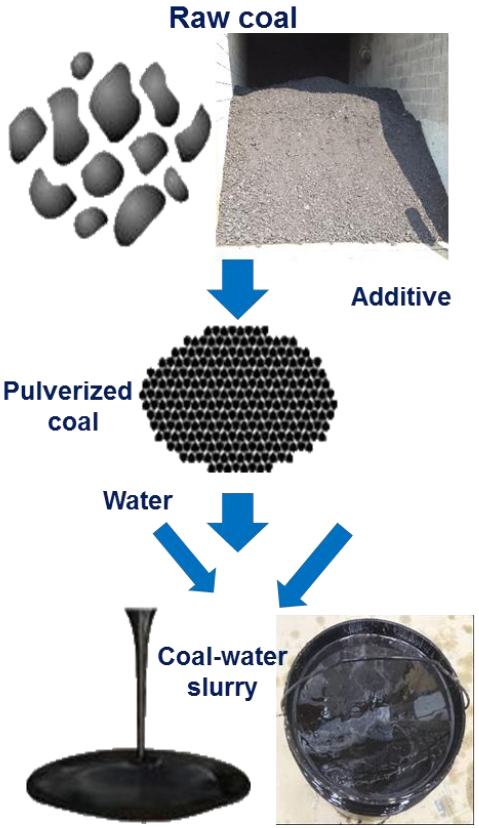
1. Modify existing OMB unit to a staged OMB gasifier
   - Demonstrate flexibility in fuel/load
   - The probability to promote in-situ WGS and partial sulfur removal
   - Refractory wall/burner protection via improved T profile
2. Standardization
   - Modularize burner design for identical burners
   - The matchability among ASU, burner and syngas turbine.
3. Techno-Economic Analysis



Technical Approach – Staged OMB



Fuel Characterization and Preparation Flexibility



Typical Properties of CWS

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

Burner Standardization and Modularization

ASU is the determiner

Slurry velocity & tip clearance

In-situ Water-gas-shift?

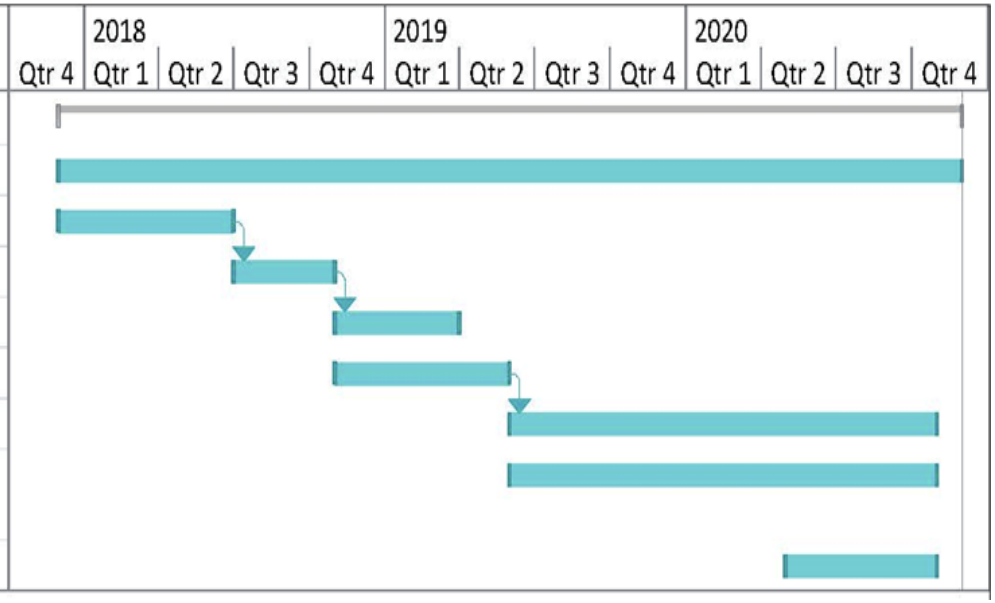
- Iron-based industrial byproduct injection at various concentration
- Residence time
- Temperature

Project Structure

Project Participant	Scope of Work
UKy-CAER	• Project lead • Schedule and overall project management • OMB pilot modification design and construction • Develop testing plan • Staged-OMB operation and testing • Data analysis • Feed characterization • Develop final staged-OMB design based on test and model results
East China University of Science and Technology (ECUST)	• 3-D modeling of the staged-OMB gasifier based on results from testing • Utilize 3-D model to optimize the staged-OMB process • Provide suggestions for process and unit modifications to improve flexibility and efficiency • Technical support on operation of UKy-CAER OMB pilot unit based on knowledge and experience from previous operations and development
Trimeric Corporation	• Perform techno-economic analysis • Estimate construction costs • Estimate operating costs • Economic comparison to commercial scale • Determine economic viability of system

Project Schedule

Task Name	Start	Finish
Staged OMB for Modular Gasifier/Burner	12/1/17	11/30/20
1 Project Management and Planning	12/1/17	11/30/20
2 Construction of the Staged-OMB Gasifier	12/1/17	6/30/18
3 Parametric Study of Staged-OMB	7/1/18	10/31/18
4 Fuel Flexibility with Fuel Blend	11/1/18	3/31/19
5 In-situ WGS Development	11/1/18	5/31/19
6 Burner Testing	6/1/19	10/31/20
7 3-D Simulation of Staged-OMB Gasifier and Burner Effect	6/1/19	10/31/20
8 Technical and Economic Analysis	5/1/20	10/31/20



Project Management Plan - Milestones

Budget Period	ID	Task Number	Description	Planned Completion Date	Actual Completion Date	Verification Method
1	1	1	Updated Project Management Plan	12/30/2017		Project Management Plan File
1	2	1	Kickoff Meeting	01/31/2018		Presentation File
1	3	1	RPPR_Q1FY18 Report	01/31/2018		Quarterly Report
1	4	1	RPPR_Q2FY18 Report	04/30/2018		Quarterly Report
1	5	1	RPPR_Q3FY18 Report	07/31/2018		Quarterly Report
1	6	1	RPPR_Q4FY18 Report	10/31/2018		Quarterly Report
1	7	1	RPPR_Q1FY19 Report	01/31/2019		Quarterly Report
1	8	1	RPPR_Q2FY19 Report	04/30/2019		Quarterly Report
1	9	2	Construction of the Staged-OMB Gasifier	06/30/2018		Deliverable File
1	10	3.1	Test of Staged-OMB	07/31/2018		Deliverable File
1	11	3.2	Parametric Evaluation of Staged-OMB	10/31/2018		Deliverable File
1	12	4	Fuel Flexibility with Fuel Blend	03/31/2019		Deliverable File
1	13	5	In-Situ WGS Development	05/31/2019		Deliverable File

Project Management Plan - Milestones

Budget Period	ID	Task Number	Description	Planned Completion Date	Actual Completion Date	Verification Method
1	14	1	RPPR_Q3FY19 Report	07/31/2019		Quarterly Report
1	15	1	RPPR_Q4FY19 Report	10/31/2019		Quarterly Report
1	16	1	RPPR_Q1FY20 Report	01/31/2020		Quarterly Report
1	17	1	RPPR_Q2FY20 Report	04/30/2020		Quarterly Report
1	18	1	RPPR_Q3FY20 Report	07/31/2020		Quarterly Report
1	19	1	RPPR_Q4FY20 Report	10/31/2020		Quarterly Report
1	20	1	RPPR_Q1FY21 Report	01/31/2021		Quarterly Report
1	21	6	Burner Design Specification Based on Burner Testing	10/31/2020		Deliverable File
1	22	7	3-D Simulation of Staged-OMB Gasifier	10/31/2020		Deliverable File
1	23	8	Technical and Economic Analysis	10/31/2020		Deliverable File
1	24	1	Final Project Report Complete	11/30/2020		Final Report

Project Management Plan – Success Criteria

Planned Date	Success Criteria
6/30/2018	Completion of the pilot scale staged-OMB modifications and reactor ready for operation
10/31/2019	Gather data from the staged-OMB parametric testing showing improvements of the process modifications on flexibility and efficiency
05/31/2019	Gather data from in-situ WGS testing
05/31/2019	Improve carbon conversion of staged-OMB from baseline OMB conversion and cold gas efficiency by 2% with variation in feedstocks
07/31/2020	Completion of the 3-D modeling of staged-OMB process based on data from UKy-CAER testing
10/31/2020	A finalized engineering process design and Aspen-Plus based simulation model; equipment list and sizing; technical-economic analysis including capital and O&M cost estimates; for the 1-5MW scale

Acknowledgements

- DOE-NETL: Arun Bose and David Lyons
- CAER: Andy Placido, Lisa Richburg and Don Challman
- ECUST: Qinghua Guo and Jianliang Xu
- Trimeric: Andrew Sexton