Fog+Froth-based Post-combustion CO_2 Capture in Fossil-fuel Power Plants, DE-FE0031733

Objectives

Develop and demonstrate a transformational compact CO_2 absorber with internal fog and froth formation to lower the capital cost of CCS

- Fabricate, integrate, and research a compact absorber at the bench scale
- Conduct parametric and long-term campaigns
- EH&S assessment, TEA, TGA, TMP, State Point Data Table

Participants

Center for Applied Energy Research

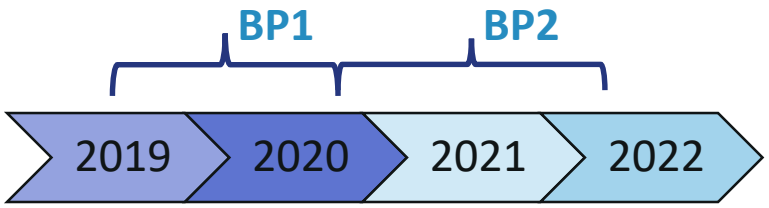
ICS Industrial Climate Solutions INC

Nexant

SMG Smith Management Group

Performance Dates

BP1: May 1, 2019 to October 31, 2020
BP2: November 1, 2020 to March 31, 2022



Funding

Total	Federal Share	Cost Share
$3,685,427	$2,947,404	$738,023

Technology Background

Use the WFGD example to compare and contrast with CCS.

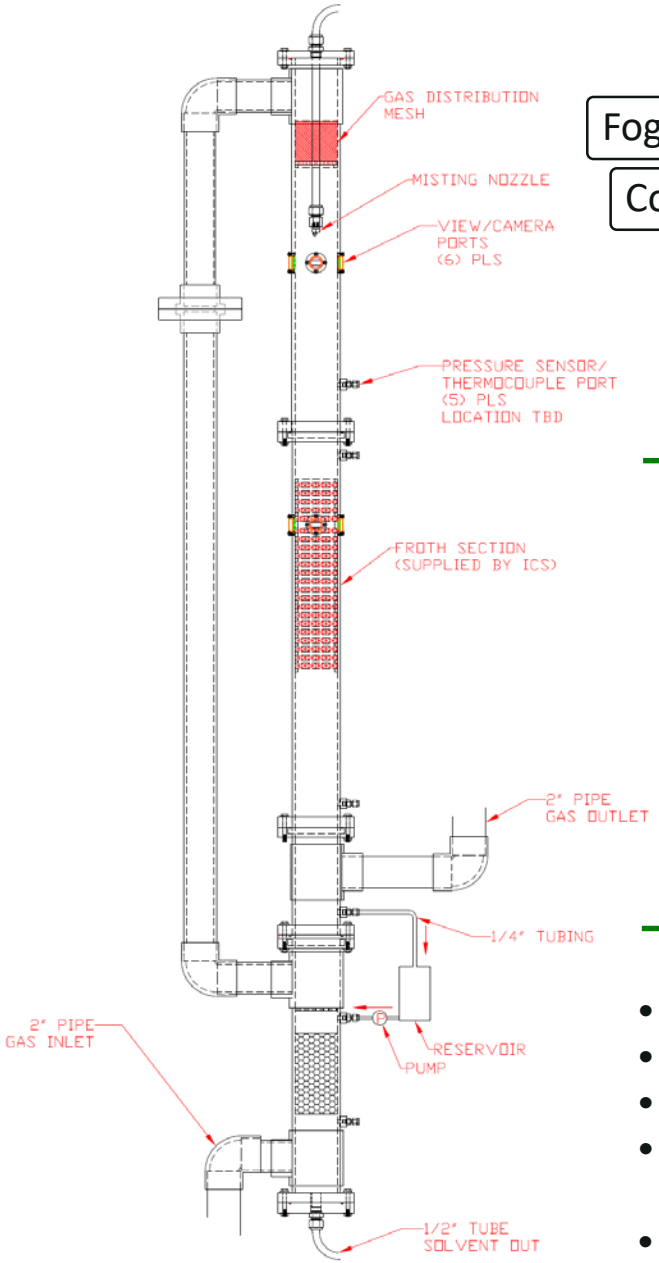
Aspects	Unit	WFGD	CCS
L/G	-	10	3.5
Effective Wet Surface per Unit of Volume	m^2/m^3	1523.8	200.0
Reactant Concentration	mol/m^3	0.03	1262.5
Diffusivity	m^2/s	1.2E-05	2.0E-09
Reaction Kinetics, K_2	M^{-2}	10000	3000
Inlet Concentration	vol %	0.3	12.5
Outlet Concentration	vol %	0.01	1.6
Log Mean Driving Force	kPa	0.07	4.33

$$k_g' = \frac{\sqrt{D_{CO_2} K_2 [Am]}}{H_{CO_2}}$$

$$flux = A \cdot k_G (P^g{}_{CO_2} - P^*{}_{CO_2})$$

Assuming Pseudo-first Order	WFGD	Traditional CCS	Compact Absorber
Henry's Law Constant	1	1	
Reaction Kinetics in Absorber	1	0.5	
k_g'	1	2.0	5.6
Effective Surface Area	1	0.13	0.39
Driving Force	1	62.34	
Overall Mass Transfer per Volume	1	16.6	137
Removal Loading @ 90% CO_2 and 99% SO_2 captured	1	37.88	
The Absorber Size Required	1	2.28	0.28

Technical Approach



Plan

- Fogging and Frothing Sections Design and Fabrication
- Cold Unit - Fogging and Frothing Sections Evaluation
- Bench CCS - Parametric Campaign
- Bench CCS - Long Term Campaign
- TEA, TGA, EH&S

Milestones

7/31/2019 TMP Complete
9/30/2019 Fabrication and Testing of Fog and Froth Sections
4/30/2019 Compact Absorber Constructed and Integrated at Bench Scale
8/31/2020 Parametric Campaign Complete
12/31/2021 Long-term Campaign Complete
10/31/2021 TEA Complete
12/31/2020 State Point Data Table Complete
3/31/2022 TGA and EH&S Complete

Success Criteria

- Compact absorber with liquid/gas contact area increased by 5X
- Mass transfer enhancement by 4X
- Long-term verification of compact absorber functionality
- TEA that shows a capital cost savings of ≥10% and cost of CO_2 capture reduction of ≥15% with an absorber column that is ~70% shorter
- EH&S assessment shows no impediment to technology development