Algae-based CO_2 Capture from Power Plants and Conversion to Value Added Products

Helios-NRG, LLC

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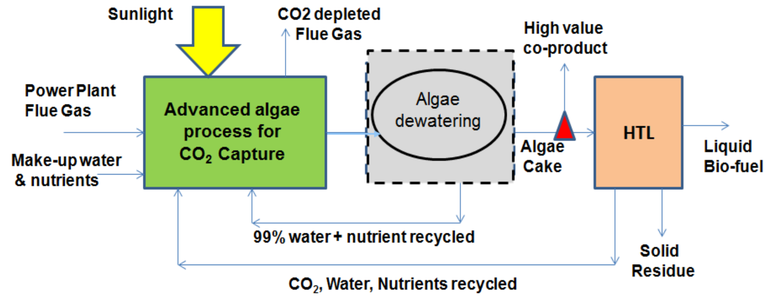
Project Overview

Overall Objective

1. Develop a novel algae technology for efficient CO_2 capture from coal power plant flue gas
2. Make bio-fuels & other products from algae to mitigate the cost of carbon capture

Strategy

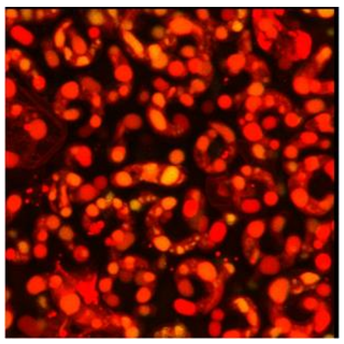


1. Utilize micro-algae to metabolize and capture CO_2
2. Enable high CO_2 capture efficiency and productivity
3. De-water the algae at low energy & cost
4. Recycle water & nutrients to minimize consumption
5. Convert the algae to fuel via HTL process
6. Extract high value co-products

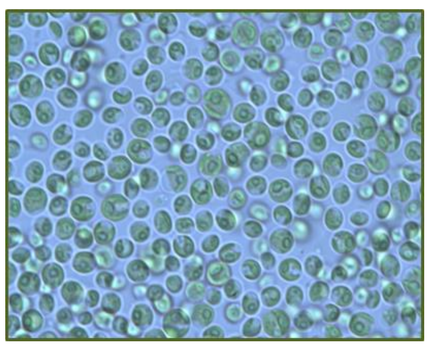
Challenges in Algae CO_2 Capture

1. Complex living system – prediction difficult
2. 12% CO_2 is 300x of ambient
3. Impact of SO_X and NO_X unknown
4. Growth rate & capture efficiency often inversely related
5. Achieving 90% CO_2 capture efficiency is difficult
6. All downstream applications require dewatering

Microalgae Strains

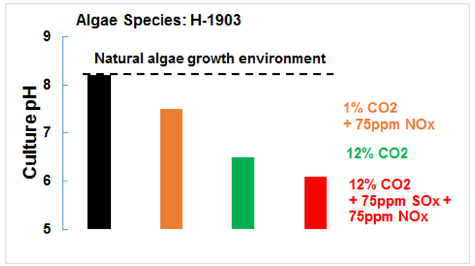


H-1903

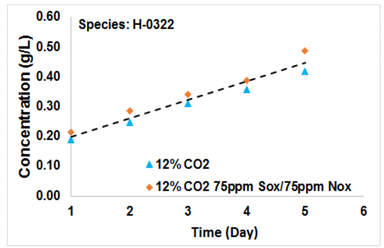


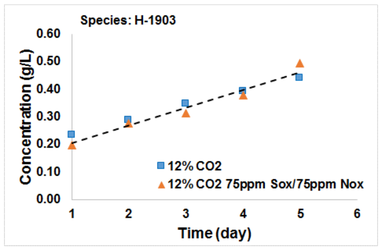
H-0322

Algae Survival in Template Post FGD gas



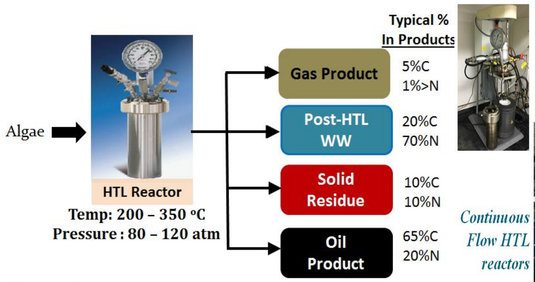
Major contaminants induce significant change in algae environment





Stable algae growth demonstrated for H-0322 and H-1903 at 12% CO_2 + 75ppm SO_x + 75ppm NO_x

Hydrothermal Liquefaction (HTL) of Algae

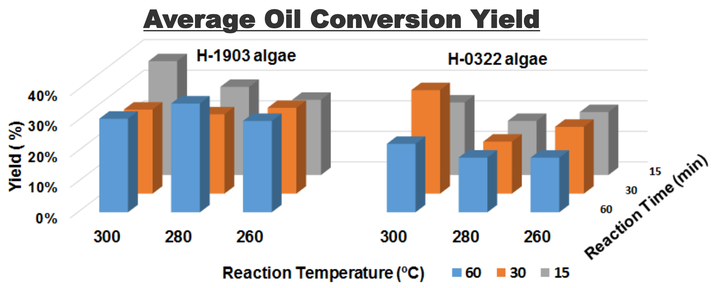


Batch HTL reactors

Continuous Flow HTL reactors

Benefits:

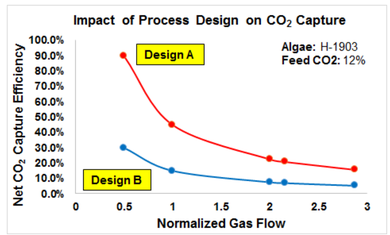
1. Can process wet biomass including slurry (~20 wt% solid)
2. Produces liquid bio-crude -easily used in existing infrastructure
3. High biomass utilization
4. No catalyst needed
5. Most nutrients remain in solution & can be recycled to algae
6. Favorable Economic & Energy Balances Projected
   - Diesel cost from HTL = $1.54/gal + feed cost (DOE-BETO)

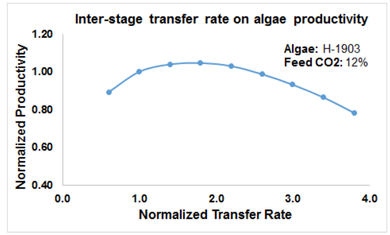


Advanced Algae Process for CO_2 Capture

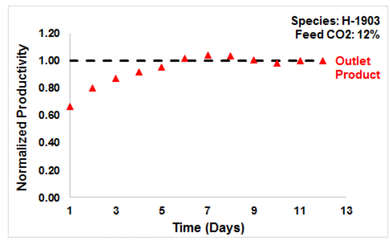
1. Continuous process
2. 90% CO_2 capture efficiency achievable
3. Design of each stage remains optimal over time
4. Enables stable capture efficiency with time
5. High productivity
6. Suitable for integrating with upstream/downstream processes

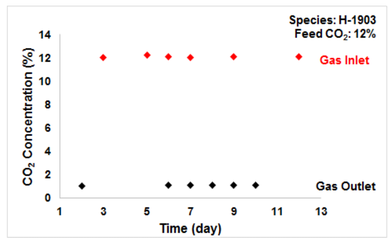
Model Simulation





Experimental Results





- **Stable algae concentration and CO_2 capture efficiency demonstrated**
- **High overall CO_2 capture efficiency achieved**

Conclusions

- Survival & growth of two algae species validated in simulated flue gas
- >80% CO_2 capture efficiency demonstrated
- Good HTL conversion of algae to bio-crude demonstrated
- Co-product generation economically valuable
- Preliminary economic assessment shows potential for CO_2 capture cost <$30/ton

Acknowledgement

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