Hydrogen from Microalgae

Senior Design Group 9
Sponsored by FAMU-FSU College of Engineering

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Background

- Collaboration with Universidade Federal do Paraná (UFPR)
- Continuation of 2012 and 2013 Senior Design Projects
- 2012 Project:
  - Optimize algae extraction from a photobioreactor (PBR)
  - Algae and CO_2 concentrations
  - Mass flow
- 2013 Project:
  - Design a continuous PBR
  - Addition and Extraction Units

Microalgae for Biofuel

- Rapid growth rates
- High oil content
- Raw materials required are abundant
- Grow in adverse conditions
- Efficient energy converters

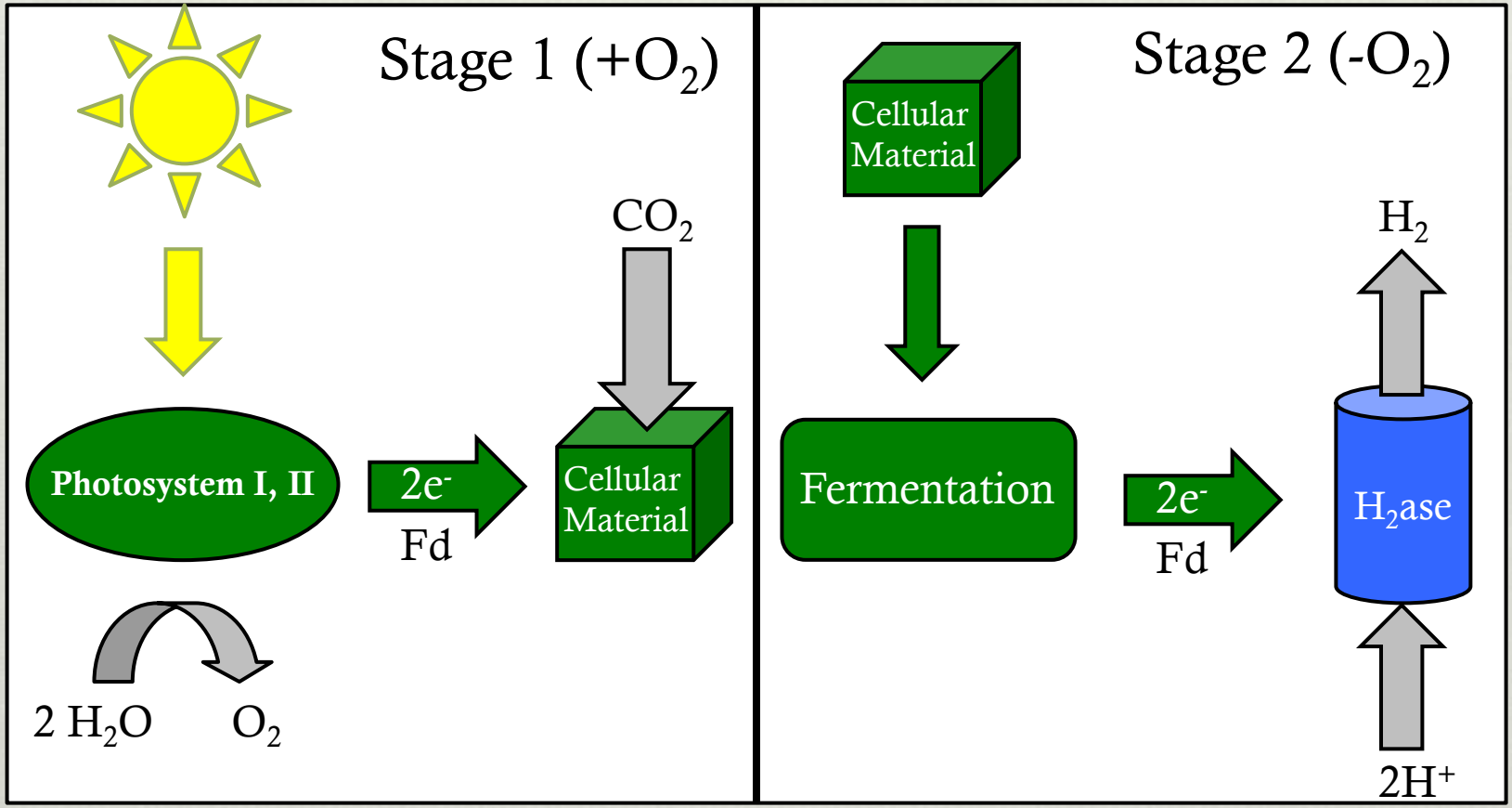
Objectives

- Maintain a hydrogen (H_2) producing photobioreactor system
- Design and calibrate an electronic H_2 mass measuring sensor
- Produce enough biofuel to be tested
- Create drawings of the bioreactor and sensor designs
- Submit invention disclosure (USA) and patent (Brazil)

Potential Challenges

- Appropriate bioreactor design
- Sustainment of cultivation and productivity of algae
- Reduction of cell damage to microalgae
- Product and fabrication costs
- Maintenance
- Scaling for industrial capabilities

Methodology



Methodology

Algae Species

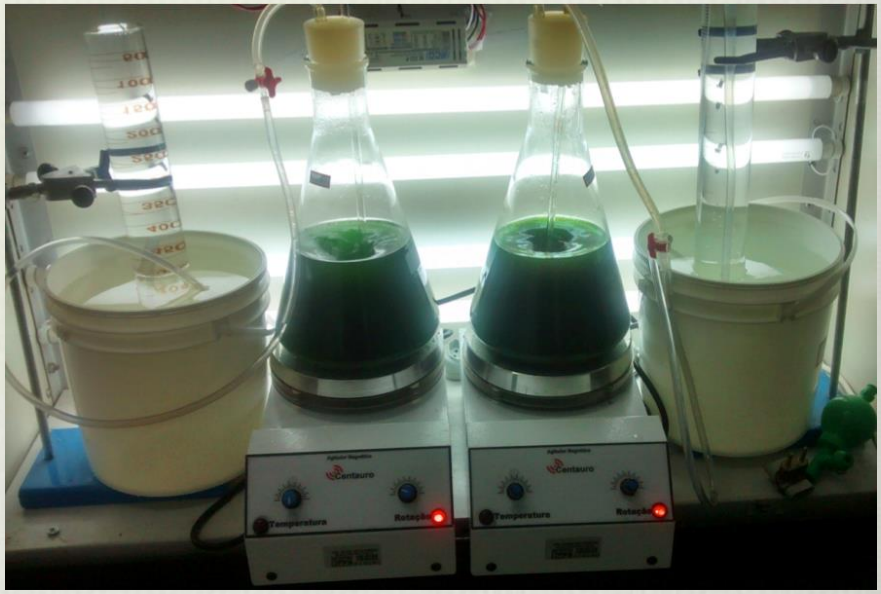
- Scenedesmus sp.
- Chlamydomonas reinhardtii (strain CC-125)
  - Mutant Strain (CC-4170)
  - Increased H_2 Production

Growth Mediums

- Copper enriched and Sulfur deprived
  - Both have similar effects on algae
    - Block creation of enzymes
    - No photosynthesis without enzymes
    - Anaerobic environment promotes H_2 production
- Cu best at producing H_2 continuously

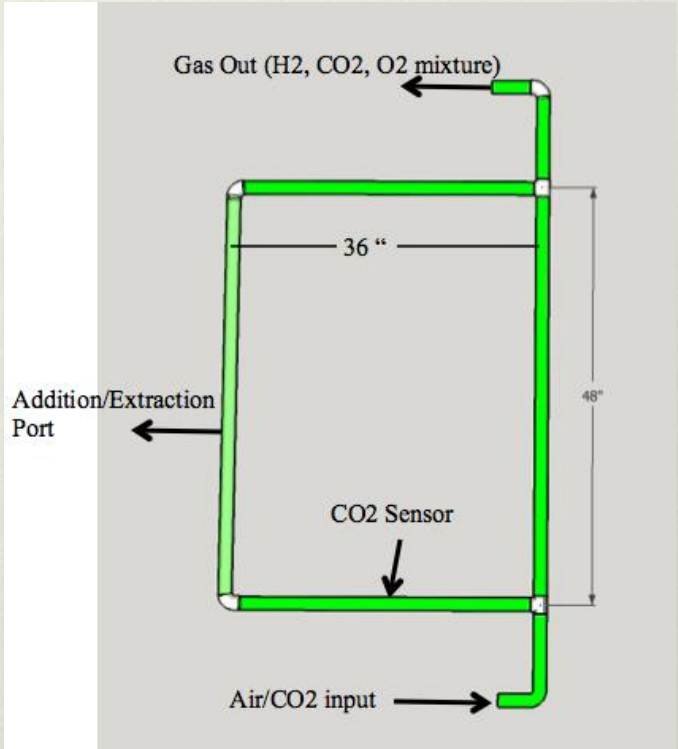
Tests Performed - UFPR

- Failed to determine H_2 presence for Scenedesmus strain
  - Initial experiment utilized balloon for gas collection
- The imported chlamydomonas reinhardtii strain produced H_2
- The sensor was able to identify H_2 production



Photobioreactor Design

- Use previous senior design prototype with small modifications
- 2013 size: 8'x4' → 2014 size: 4'x3'
  - Allows for artificial light and a reduce in volume of algae needed
- Addition/Extraction will not be used for our purpose
- CO_2 Sensor might be used
- Air/CO_2 Input done with commercial air pump
- 18 ft. of clear 1.5 PVC pipe

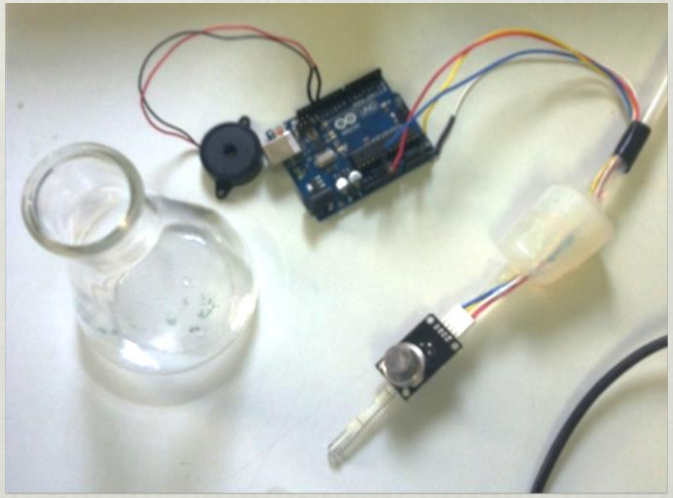


H_2 Purifier

- Oxygen and CO_2 must be removed to achieve a higher level of hydrogen gas purity
- Constructing membranes is too costly and time insensitive
  - Purifier works by same principle, but is drastically cheaper
- Purifier Specs:
  - Max flow rate 5 L/min
  - Operating pressure of 5 psi to 125 psi
  - Fitting size of 0.25 in
- Installed vertically to ensure efficient removal of contaminants
- High efficiency and low resistance to gas flow

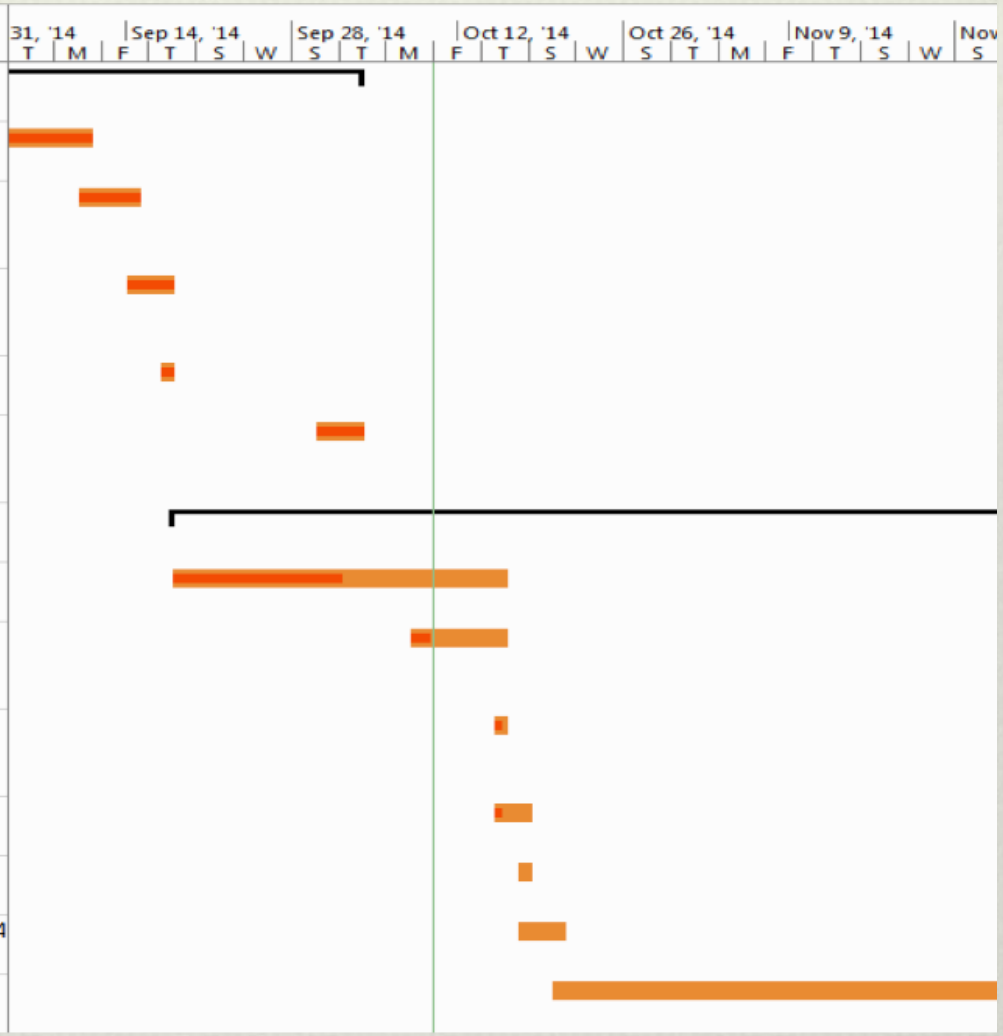
Hydrogen Sensor

- Main components include:
  - MQ – 8 Hydrogen Gas Sensor
  - Anduino Uno Board
- Advantages:
  - Inexpensive
  - Simple design
  - High Sensitivity
- Disadvantages:
  - No direct readout of concentration
  - Calibration Required
  - Time Intensive



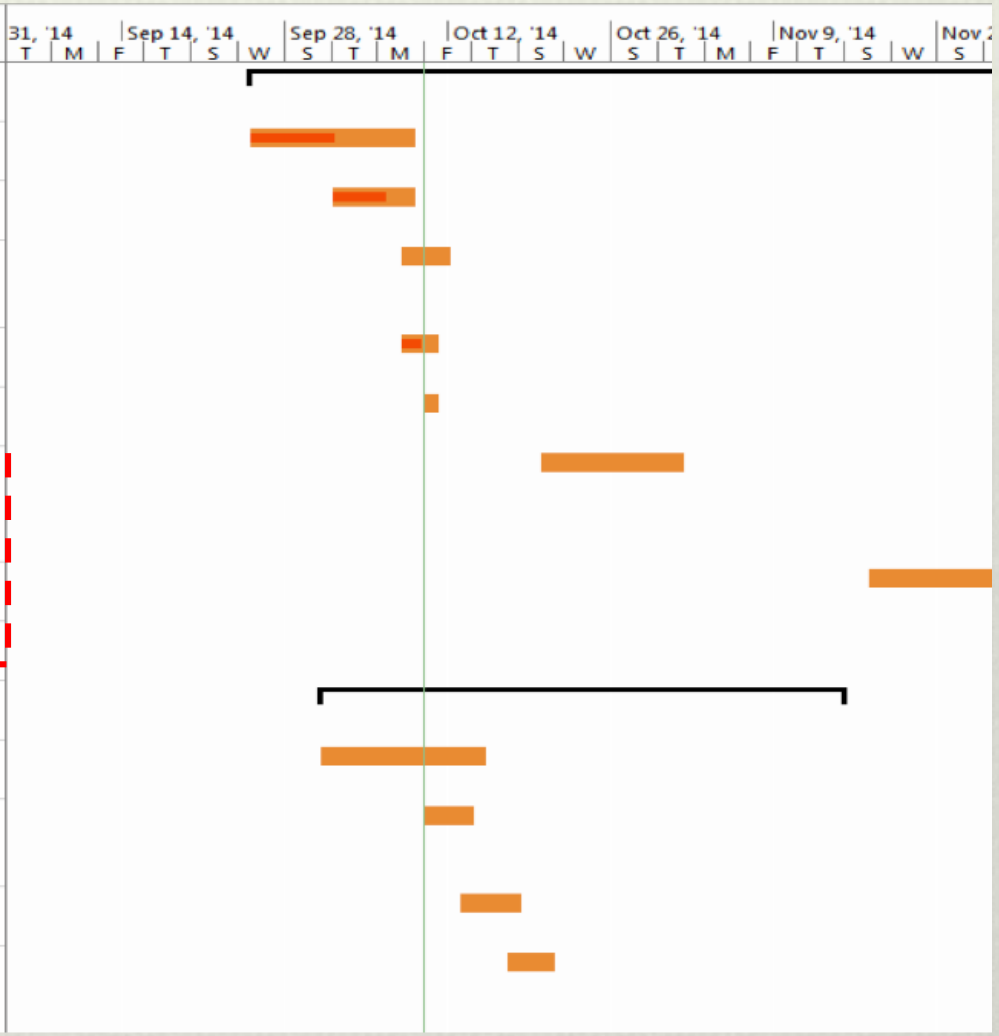
Gantt Chart

Task Name	Duration	Start	Finish
Initial Planning	**22 days**	**Thu 9/4/14**	**Fri 10/3/14**
Development of Project Goals	5 days	Thu 9/4/14	Wed 9/10/14
Development of Project Responsibilities	3 days	Wed 9/10/14	Sun 9/14/14
Assignment t of Project Responsibilities	3 days	Sun 9/14/14	Wed 9/17/14
Sponsor Meeting	1 day	Wed 9/17/14	Wed 9/17/14
Development of Project Methodology	4 days	Tue 9/30/14	Fri 10/3/14
Microalgae Growth	**62 days**	**Thu 9/18/14**	**Fri 12/12/14**
Algae Growth Research	20 days	Thu 9/18/14	Wed 10/15/14
Evaluation of Equipment Needed	6 days	Wed 10/8/14	Wed 10/15/14
Evaluation of Equipment Available	1 day	Wed 10/15/14	Wed 10/15/14
Cost Analysis	3 days	Wed 10/15/14	Fri 10/17/14
Work Order for Supplies	1 day	Fri 10/17/14	Fri 10/17/14
Microalgae Set U	2 days	Fri 10/17/14	Mon 10/20/14
Growth Maintenance	40 days	Mon 10/20/14	Fri 12/12/14



Gantt Chart cont.

Task Name	Duration	Start	Finish
Hydrogen Sensor Development	**57 days**	**Thu 9/25/14**	**Fri 12/12/14**
Hydrogen Sensor Research	10 days	Thu 9/25/14	Wed 10/8/14
Sensor Design Development	5 days	Thu 10/2/14	Wed 10/8/14
Evaluation of Equipment Needed	3 days	Wed 10/8/14	Sat 10/11/14
Cost Analysis	3 days	Wed 10/8/14	Fri 10/10/14
Work Order for Parts	1 day	Fri 10/10/14	Fri 10/10/14
Sensor Development/ Reprogramming/ Calibration	10 days	Mon 10/20/14	Fri 10/31/14
Sensor Testing	15 days	Mon 11/17/14	Fri 12/5/14
Testing Anaylis	6 days	Fri 12/5/14	Fri 12/12/14
Photobioreactor Development	**33 days**	**Wed 10/1/14**	**Fri 11/14/14**
Photobioreactor Research	10 days	Wed 10/1/14	Tue 10/14/14
Evaluation of Current Bioreactor	2 days	Fri 10/10/14	Mon 10/13/14
Development of Modifications	5 days	Mon 10/13/14	Fri 10/17/14
Evaluation of Equiptment Needed	2 days	Fri 10/17/14	Mon 10/20/14



Summary

- Scenedesmus Sp. and Chlamydomonas Reinhardtii, and possibly a mutant variation for higher H_2 output
  - Chlamydomonas Reinhardtii has already produced H_2 in the lab (UFPR)
- Modification of last year's photobioreactor design will be used
- Sensor is assembled and is currently being programmed, calibrated, and tested
- Challenges include:
  - Sustaining algae
  - Programming H_2 sensor
  - Large scale implementation

Questions?