

## Design and Development of a Gas Coupling Unit for Trigeneration and Algae Photobioreactor Systems







## **Team Members:**

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## **Scope Revisited**

- Use CO<sub>2</sub> for photosynthesis in Photobioreactor.
- Sequester CO<sub>2</sub> from the exhaust stream.
- Couple exhaust with Photobioreactor via a scalable system.
- Perform Life Cycle Analysis on American system.











- Consume the CO<sub>2</sub> produced during the combustion;
- Use the exhausts gases to increase the algae growth;
- May produce Biodiesel by the algae fat;
- Sustainability;







### What is the idea?

#### International Team 11









## **System Coupling**





## **System Coupling**

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The first downstream part of the coupling device is shown

- 1. Condensate/excess gas outlet
- 2. Particulate filter
- 3. Hose barb leads to air pump









## Life Cycle Analysis

- LCA will be carried out on:
  - FSU's Photobioreactor array.
  - FSU's Trigeneration system.
  - Coupling System.
- LCA performed last semester on UFPR's large photobioreactor yielded:
  - Environmental impacts due to materials used in production.
  - Viability of structure design.
  - Land use necessary to meet standard biodiesel production.







## What has been completed since the last presentation

- Refrigerator has been attached to the trigenerator using new installed piping.
- pH sensors were checked. Three pH sensors were not used properly during the last senior design project, therefore all pH sensors must be replaced.
- Exhaust gas temperature was checked (Infrared Temperature Sensor and Thermocouples). Steady state: 39-40°C.
- Air pumps and diffusers received.
- Coupling system parts were purchased and cut to size; the coupling system framework was assembled.









## What has been completed since the last presentation

- All components have been ordered.
- Yet to receive some components:
  - Water pump
  - pH sensors
  - Solenoids
- New algae supplier selected due to ordering problems
  - New Supplier- Carolina Biological Supply Company
- Back-up Algae cultures have been inoculated
  - Chlorella vulgaris and Scenedesmus
- Website updated
  - New content, photos, minor fixes





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### **Potential Problems, Solutions**

## Unwanted/harmful chemicals in exhaust stream Nitrous oxides (NO<sub>x</sub>)

Algae will consume, not threatening to parts

### Unburnt hydrocarbons (C<sub>x</sub>H<sub>y</sub>)

Harmful to air pump and algae
Some will condense in H/X and be expelled upstream

### Sulfur dioxide (SO<sub>2</sub>)

 Can form sulfuric acid in water with catalyst NO<sub>2</sub>, potentially lethal to algae

### Water vapor (H<sub>2</sub>O)

 Harmful to air pump, most will condense and be expelled upstream

Catalytic converter will not be effective on our system

### **International Team 11**

Possible solution: filter the exhaust stream through plain water upstream of photobioreactor

Hydrocarbons and water will condense and drain at this outlet









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Item	Quantity	Price	Total
Hiblow USA GP 40 Linear Air Pump 40 Ipm @ 1.7 psi, 4 psi max.	2	\$101.38	\$202.76
Shurflo Water Pump	1	\$70.00	\$70.00
Aquamedic Photobioreactors	2	\$80.00	\$160.00
Neptune Systems Order (PM1, pH probes x4, temp probe)	-	\$284.67 +\$40.00sh	\$324.67
UTEX Algae agar culture	2	\$30.00+ \$10.00sh	\$80.00
Carolina Biological Supply Co. Algae Cultures	2	\$7 + \$10 +\$17 +\$16	\$50.00
Biodiesel Supply Store & Chemicals Stainless Steel ¼" Solenoid, AC	2	\$50.33	\$100.66
Polyester Air Filter Media Pads Package of 6 - 2'' thick pads	1	\$10.85	\$10.85
PVC Pipe, barbs & fittings	-	\$40.00	\$40.00
Inline Diffusers	4	\$32.99	\$131.96
		TOTAL:	\$1,170.90







### Next Tasks

- Inoculate new algae cultures
- Analyze exhaust stream, measure %CO<sub>2</sub>
- Calibrate pH sensors upon arrival
- Set up controllers
- Finish assembly of coupling system
- Mount other Photobioreactor and prepare for inoculation





# QUESTIONS ???





