Recreate Energy: Energy for a Brighter Future

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Heating and Cooling Subteam

Omar Casarrubias
Santiago Buitron

Objective

- Design and Fabricate a Heating and Cooling Thermoelectric system to properly optimize algae growth conditions

Challenge

- The design must be cost effective, weather resistant, and a small-scale system
- The Heating and Cooling system will contain Peltier Modules
- System must be controlled via Arduino

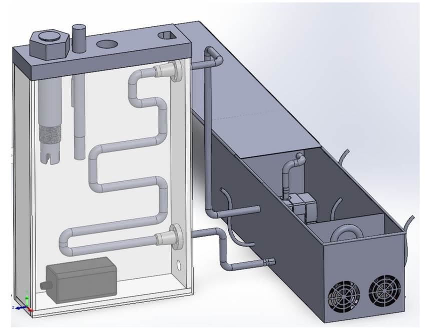

Figure 1: Outer view of the heating and cooling system

Key Elements

- Box is made of 3003 Aluminum alloy
- All piping is made of PVC tubing with the exception of copper tubing inside the bioreactor
- All Water pumps submerged in reservoir section.

Future Improvements

- Update components on Heating Setup depending on future performance

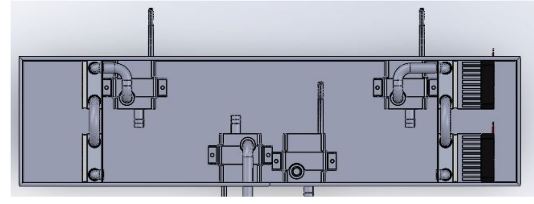

Figure 2: Inner View of the heating and cooling system

Impact on Society

- Optimal temperature conditions will allow algae to yield a consistent biofuel production.

Safety

- The box is separated by 3 sections by welded sheet metal to prevent water leakage to the electronics.

Budget

- The whole system including the three sub-teams should not exceed about $1000, so our reservoir system should be around a third of that (~$300)

Analysis

- Thermal Analysis
  - 40 degree Celsius on the left side
  - 10 degree Celsius on the right side
  - Temperature distribution shown below

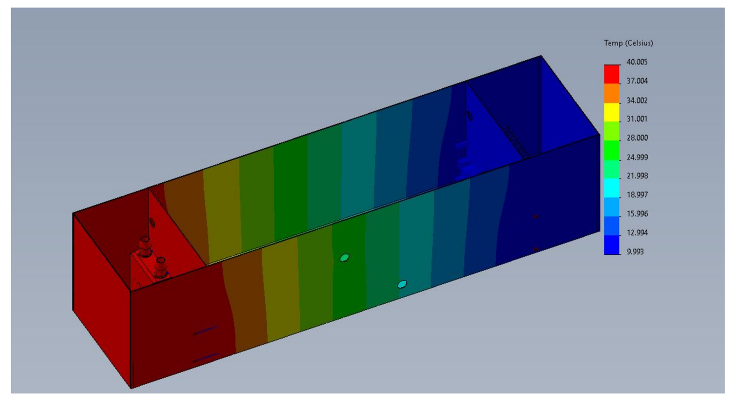

Figure 3: Thermal Analysis of System

Introduction

- Global reliance on crude oil creates a need for alternative sources
- Recreate Energy's goal is to turn algae into crude oil through hydrothermal liquefaction
- Already completed extensive research into the best micro-algae and the system to suit its needs
- Our team has 3 subteams: heating and cooling, electronic box, and electroflocculation

Existing Solutions

- Continuous Flow Reactor System at the Pacific Northwest National Laboratory
  - High temperature and pressure converts algae to crude oil with byproducts
  - Crude oil can be converted to gasoline or aviation fuel
  - Uses wet algae to avoid drying process and related costs
- Saltgae Project at Camporosso, Italy
  - Spirulina algae collected from wastewater is used to produce crude oils and other byproducts
  - Spirulina algae absorbs pollutants such as nitrates to serve as a dual purpose and purify the water

Figure A: The set up Lab at Camorosso have for their purification process

Figure B: Pacific Northwest National Laboratory's bioreactor set-up

NOTE: All designs shown are under the jurisdiction of RECREATE ENERGY under NDA

Electroflocculation System Subteam

Rene Valencia
Shaun Kim

Objective

Create a system that can pump algae and water solution in, separate algae from water, and create an algae slush byproduct that can be harvested.

Challenges

- Weather resistant, small scale, and cost effective design
- Hold 1L of fluid in tank
- Separate biomass through electrolysis
- Easy removal of two byproducts
- Compatible with Arduino

Key Elements

- Acrylic sheets for tank and electrode case
- 6101 Aluminium alloy electrodes to achieve electrolysis
- Tube brush and motor to separate algae slush
- Slanted floor to allow wastewater to exit
- Solenoids and water pumps to move fluid

Safety

- Electronics are distanced from liquid
- Relatively isolated input substance from outside environment

Performance

- Theoretically successful from simulations
- No realistic test yet (in progress)

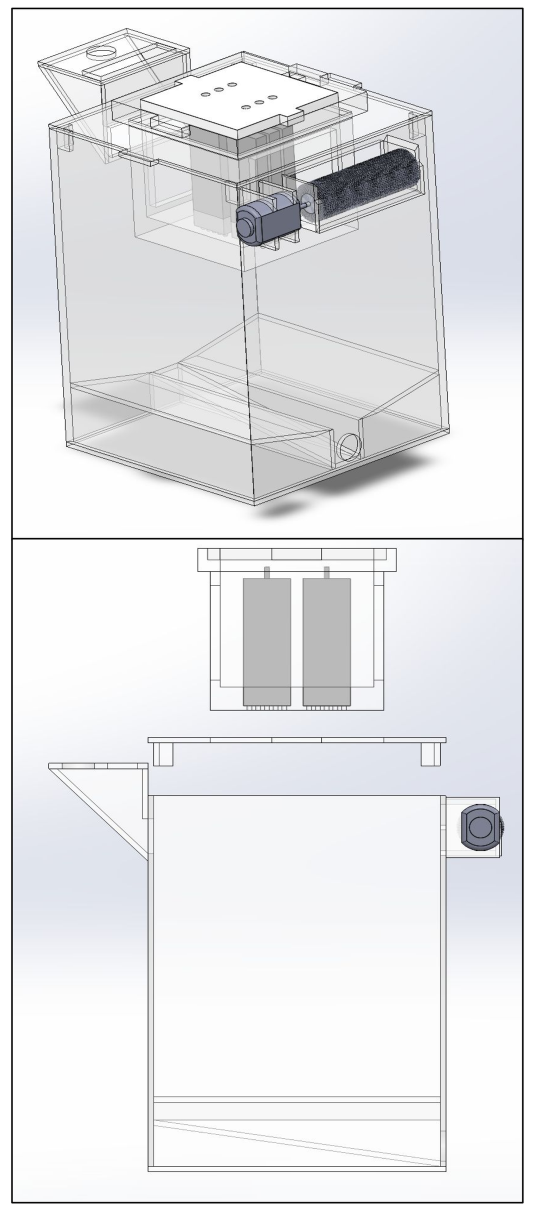

Figure 1: Angled and side view of full model.

Analysis

- Thermal Analysis:
  - 2.5 W of power to electrodes
  - Ambient temperature set to 293°K
  - Convection coefficient of Al 6101 = 218W/m^{2}K
  - No major displacement from temperature load
- Flow & Pressure analysis
  - Constraints - 0.5 m/s input speed
  - Substance - water

Future Improvements

- Input
  - Current design is simple but blocky and unknown if fit into overall system
  - May be adjusted to adapt to it
- Output
  - Unknown if algae will filter out properly
  - May need complete redesign if not working as expected
- Casing
  - Bottom takes unnecessary space without use
  - Either eliminate or make additional use for space

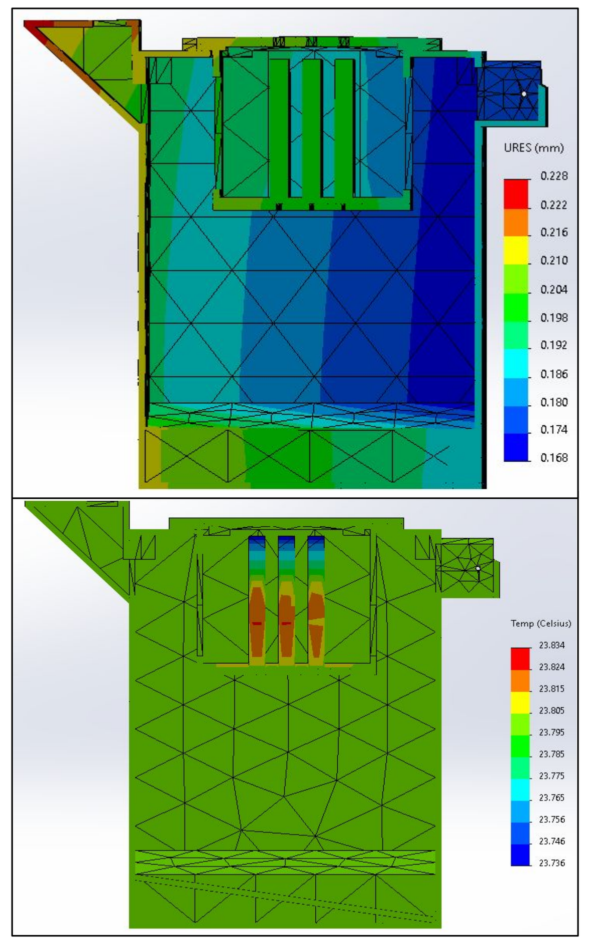

Figure 2: Thermal stress and temperature analysis of system

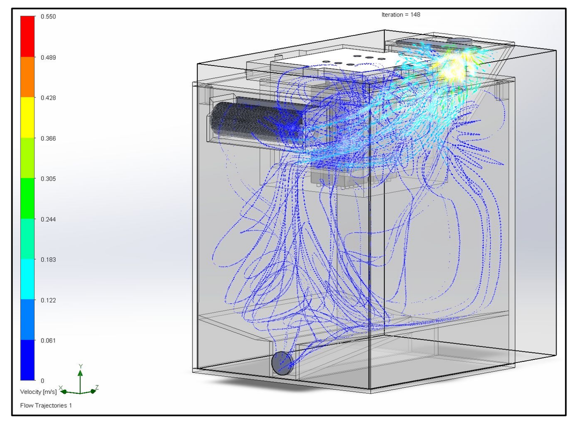

Figure 3: Flow analysis of system.

Electronic Box Subteam

Daniel Felix
Erica Stoll

Overview:

Designed protective case for the raspberry pi and arduino. The electronics must be protected from the elements and physical abuse, while still able to receive data from sensors, transmit information to databases, and regulate its own environment.

Inner Box

- Self cooling case for the Arduino, Raspberry Pi, and PCB
- Louver vents to maximize airflow while minimizing moisture entry
- Slide panel for easy access to electronics
- Ports for all connections
- Keeps the Arduino at recommended operating temperature

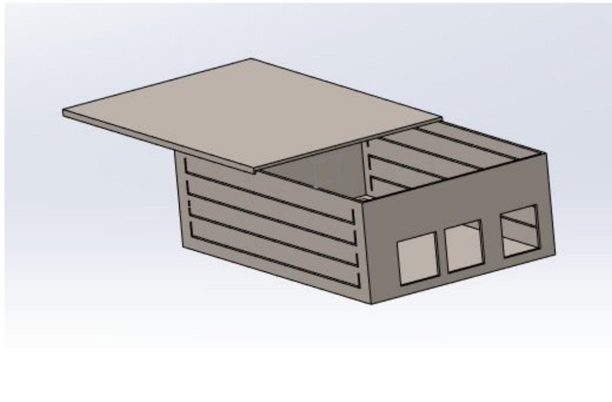

Figure 1: inner case for electronics

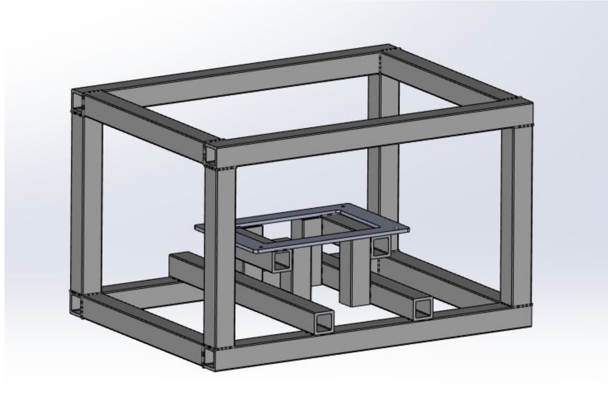

Figure 2: Outer case with mount for the inner case

Outer Box

- Steel frame to withstand blunt force
- Impact resistant mesh that allows air flow
- Solid top panel to prevent direct weather damage (sun, rain, etc.)
- Mounting platform to mount inner box

Overall Design

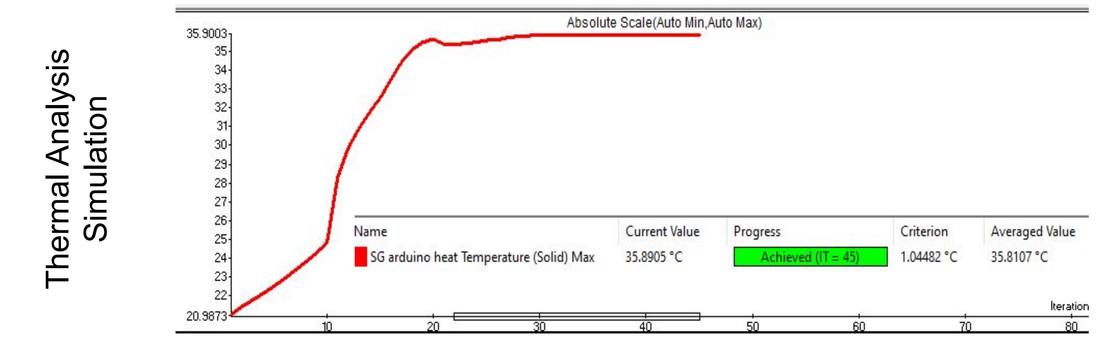

Figure 3: Thermal Analysis of System

- Arduino output at 5 Volts
- Natural Convection at 25 °C
- Average temperature running at 35.8 °C
- Recommended operating range is between -25 °C and 75°C

Manufacturing:

- Not qualified for welding -> used epoxy instead to save on cost
- Can operate without PCB hat, but should install one
- PCB minimizes manufacturing costs
- Inner case made of aluminum for its thermal conductive properties
- Outer case made of steel for its sturdy properties

Design Flaws:

- Water resistant but not waterproof; will not be able to function in heavy rain
- Have not yet run durability tests

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