Low Cost Thermophotovoltaic System

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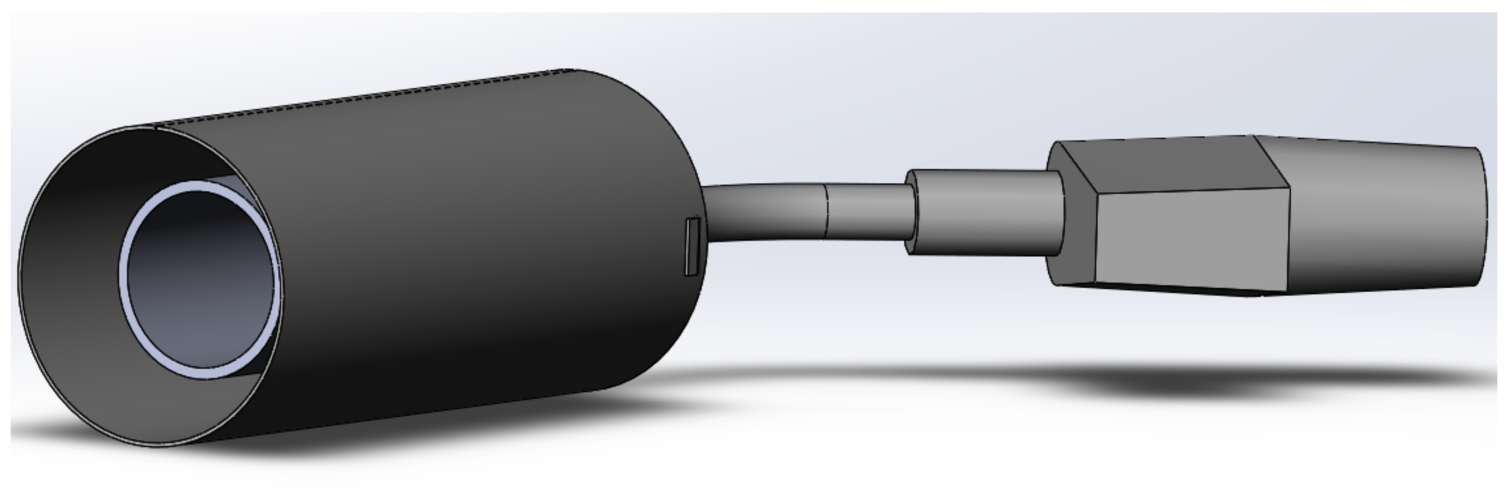
Abstract

This paper describes the process of creating a low cost and efficient thermophotovoltaic system. The system is capable of producing up to 5V of electricity using an infrared heat source. The system is also built to be compact so the user can transport it with ease.



Introduction

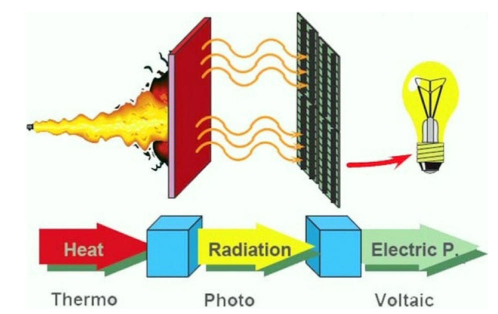
Energy production is one of the most important parts of modern life. Without the availability of electricity, today's society would not be able to exist. Throughout time there have been numerous ways of generating power. From giant factories, to wind turbines, and even hydroelectric dams, humans have invented processes to harness vast amounts of energy, however, each system has its set of drawbacks.

For starters, most power generators take up a large amount of space. It may vary from a generator the size of a room, to a powerplant that takes up acres of land. These traditional means of power generation tend to be inefficient, and most times harmful to the surrounding environment.

One promising solution to these concerns is the method of thermophotovoltaics, due to their low cost, high efficiency, and ease of use. Thermophotovoltaic systems operate similarly to a solar panel, however, instead of relying on sunlight to generate electricity, thermophotovoltaics only require a source of heat.

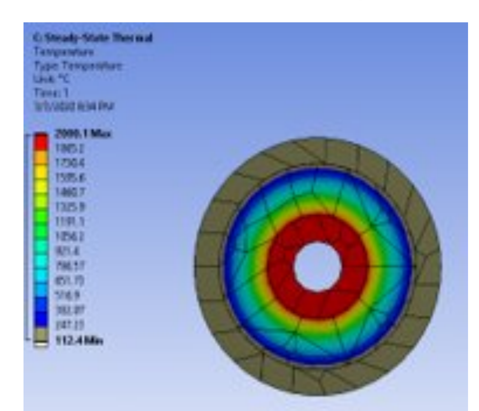
Methods and Materials

- **Combustion Chamber:** The Bernzomatic TS8000 is operable with both propane fuel and MAPP gas. For the functionality testing and simulations propane was used with an approximate temperature of 1750 degrees Fahrenheit.
- **Emitter:** Graphite carbon emits near black body infrared radiation at a low temperature of 1600 to 1700 degrees Fahrenheit at the surface.
- **Photodiode:** Responsible for capturing infrared radiation from the heated emitter and generating electricity.
- **Power Generation:** The system operates when a fuel source is ignited within the combustion chamber, causing the emitter to heat up. Once the emitter reaches a certain temperature, it will begin releasing infrared radiation which will be absorbed by the photodiodes and turned into electricity.

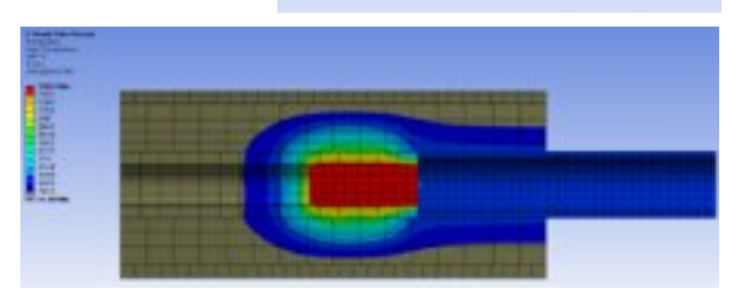


Results

Unfortunately, due to the COVID-19 pandemic, testing was put on hold and the result was a virtual device that was used for multiple simulations to determine the results.



The test simulation according to ANSYS the outer surface of the emitter will average between 1600 and 1700ºF at the outer surface to radiate the Infrared heat required for the photodiode cells to reach maximum Functionality.



A replacement photodiode was used due to shortages caused by COVID-19.The QED123 LED photodiode generated 2.6V, only half of what was expected from the desired photodiode.

Discussion

Due to the COVID-19 virus, a physical prototype was not able to be built, therefore the project had to be simulated. Although the data from the simulations comes close to what was expected from the device, the most accurate results cannot be determined without a physical trial.

Nevertheless, the data shows that thermophotovoltaics offer a way to generate power, while also offering ease of use.

Conclusions

The thermophotovoltaic system offers a lot of potential across many different facets of engineering with the focus being development for the micro scale and biomedical applications. The challenge ahead with the application of the TPV system is power density. The efficiency of the system, which is also related to the power density, is another area seeking improvement as the future generations of TPV systems are developed.

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