Modifying Ocean Thermal Energy Conversion for Land-Based Operations

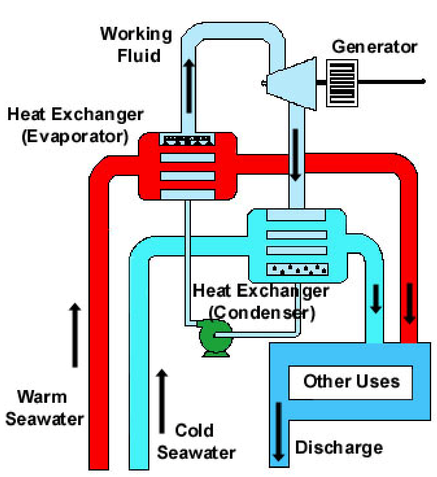
Weston Kogachi and Justin Cerrato

WKK1@Alfred.edu and JCC5@Alfred.edu

Abstract

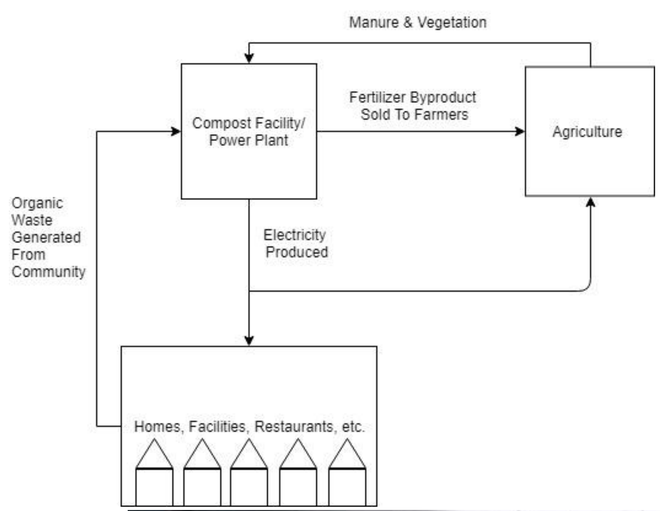
The problem with wind and solar energy is that they are dependent on the weather. This questions their reliability and resiliency. If there's less wind or if there's a cloudy day, turbines and solar panels decrease in power production, leading to a decrease in reliability. As a result, events like these reduce its resilience. Taking the concept of Ocean Thermal Energy Conversion, or OTEC, and modifying this technology suitable for land operations, is a design that can fix the core problems that come with solar and wind. OTEC utilizes warm sea water on the surface of the ocean to boil liquid ammonia into a gas. That then turns a turbine which condenses back into a liquid using cold deep-sea water. Because the surface temperature is always warmer than the deeper sea water, generating electricity is constant no matter the weather conditions, providing reliability and resiliency. For the state of New York, modifications can be made using compost and outside air or water to heat and cool down the same type of liquid.

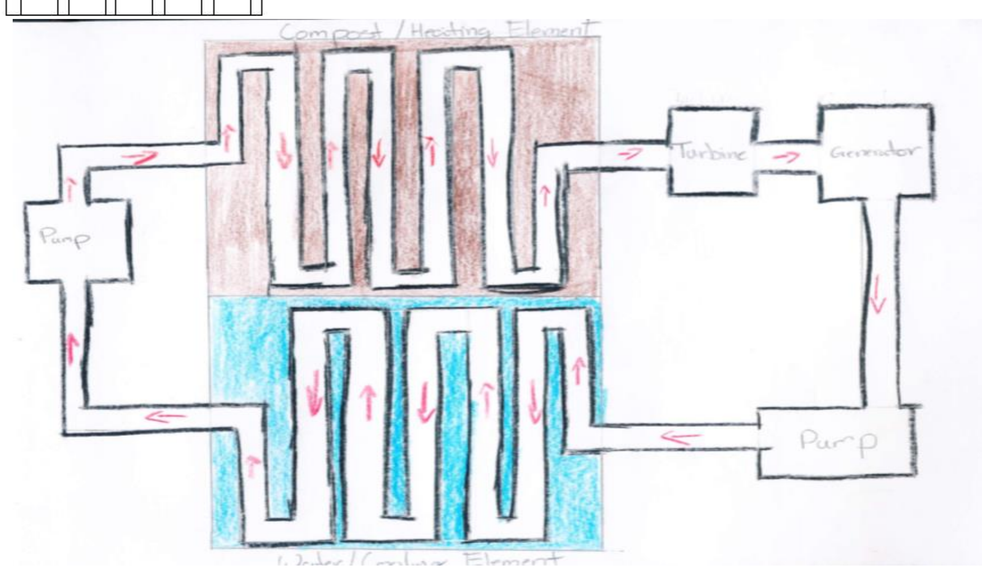
Current OTEC System



Ideas and Discussion

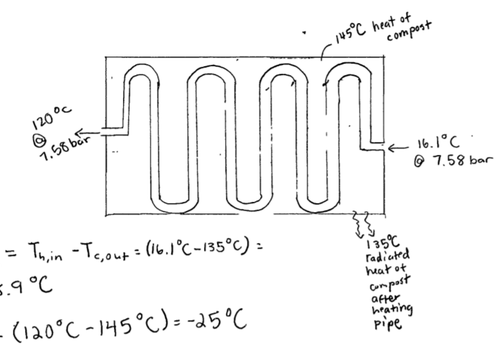
When organic matter decomposes, the bacteria that breaks down the matter also gives off heat as a byproduct. Utilizing this phenomena, organic waste generated by people can be sent to a composting facility where the heat can be used to generate electricity. What's leftover from the decomposed material results in fertilizer which can be sold back to farmers for their crops and livestock. This lifestyle will incentivize people to give their organic waste, which currently ends up in landfills, towards a cause that will benefit them in the form of electricity. This results in a symbiotic relationship between the community and the environment, promoting a sustainable future.





Results

This project was solely based off of the physical data for ammonia found online. Using the properties of ammonia, and assuming that the fluid was under pressure and the heat transfer was under ideal conditions, calculations were made to give an estimate on a small scale level of the approximate power being produced, as shown below.



$$\Delta T_{h,in} = T_{h,in} - T_{c,out} = (16.1°C - 135°C) = -118.9°C$$

$$\Delta T_{out} = (120°C - 145°C) = -25°C$$

$$\Delta T_{lm} = \text{avg. temp. difference} = \frac{-118.9-(-25)}{\ln\left(\frac{-118.9}{-25}\right)} \approx -60.22°C$$

$$\dot{Q} = UA\Delta T_{lm} = \left(1205.26\times10^{-3}\ \frac{W}{m\cdot K}\right)(22.1\ m^2)(212.93\ K) = 5671.66\ \text{Watts} = \boxed{5.671\ kW}$$

The Next Step

Due to this project based heavily on theoretical calculations, physical testing of this process is required on a small scale in order to gather real data which can then be compared to the calculated data. If both data gathered and calculated are close, a larger scale can be done for further testing. Greater changes in temperature gradient, size and shape of copper piping used to transport ammonia should be tested for increases in energy output.

Conclusion

The amount of power generated by using the heat created by bacteria during the decomposition of organic material, is greater than the average power output of a solar panel. It also has potential to be scaled on an industrial scale to compete with the power output made from wind turbines while having the same reliability as coal power plants. As a result, this idea of modifying current techniques of OTEC towards land use could potentially be both reliable and resilient leading to a sustainable, renewable future.

References

1. Çengel Yunus A. *Heat Transfer a Practical Approach*. McGraw-Hill, 2006.
2. "Ocean Thermal Energy Conversion Grand Opening of the Makai OTEC Plant." *Makai Ocean Engineering*, www.makai.com/ocean-thermal-energy-conversion/.Lee, Kevin. "How Much Power Does a Wind Turbine Generate?" Sciencing, https://sciencing.com/much-power-wind-turbine-generate-6917667.html. 24 April 2018.
3. *United States Department of Labor*, Online Database, www.osha.gov/SLTC/etools/ammonia_refrigeration/ammonia/index.html.

Alfred University
THE INAMORI SCHOOL OF ENGINEERING

1st Annual AU ENERGY Symposium, Oct. 12, 2018, Inamori School of Engineering, Alfred University (portion of the design credits to B. Myers)