WaterPURE

Water Purification Under Radiant Environments

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Abstract

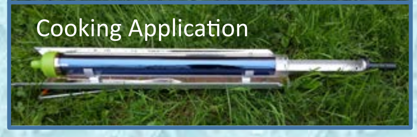
According to the World Health Organization, ten percent of the global population lacks access to clean drinking water, and between six and eight million people die annually from water-born pathogens. Many water purification systems have high initial costs and complicated, difficult-to-replace components, making them unaffordable and unrealistic in developing countries. Fortunately, many countries in need of clean drinking water coincidentally have abundant solar access. Through the utilization of this renewable resource and affordable concentrated solar technology, a thermal pasteurization system yields great potential to help the millions of people lacking potable water, without emitting climate change-inducing greenhouse gases and other harmful pollutants. This system, named WaterPURE, combines elements of the two major types of thermal pasteurization techniques, allowing for the safety guarantee of one, and the autonomy of the other. A comprehensive knowledge of thermodynamic principles, microcontroller coding, and pathogenic inactivation kinetics was expanded upon during the design phase of this research. System construction, testing, and modification will provide data for analysis and ultimately, a sustainable method of pasteurizing water for drinking.

Thermal Pasteurization and Cooking Applications

Thermal pasteurization for water purification uses heat to raise the temperature of water past a point in which pathogens can survive or remain capable of causing anthropomorphic sickness upon consumption. Unlike the majority of water purification techniques, thermal pasteurization is not hindered by turbidity in the water supply. Turbidity, or cloudiness caused by suspended organic matter, is a common characteristic of water harvested in developing countries, which gives thermal pasteurization techniques an edge over alternatives.

The most commonly utilized fuel for cooking is biomass. Unfortunately, this can cause deforestation surrounding the communities and numerous health implications from the smoke released indoors from its combustion.

The WaterPURE system is multi-functional. In addition to purifying drinking water, the evacuated tube and reflector can be detached from the rest of the structure and used as a solar oven. Solar cooking can reduce the depletion of resources in rural communities and keep women and children healthy by limiting the amount of smoke they breathe daily.



Analysis

The WaterPURE project is a feasibility study for a concentrated-solar water pasteurization system designed for integration in developing countries as a method of improving global access to clean water. Initial research was complied with the intention of designing and constructing a system shortly thereafter. The manufacturing and testing stages of WaterPURE revealed various obstacles with the design of the system. The hybrid batch/flow-through design requires automation for the system to be functional, which results in a product that is either far too expensive to be feasible in developing nations, or is considerably more complicated than it needs to be.

On an average day at 30° N latitude, the system will produce about 5.6 liters per day. If the average adult requires approximately two liters of drinking water per day, this will satisfy the drinking water demand for two adults, and perhaps a child. Modifications for a second system design include a larger reflector, and a simpler design with no required automation.

Despite the complications associated with the tangible system, thermal pasteurization as a method of water purification remains a viable solution for developing countries, particularly if the harvested water is highly turbid. WaterPURE is merely a starting place for research, which will continue in the future.

Testing

Testing was done using the Suncooker solar oven to determine the batch size and efficiency of the evacuated tube and reflector. Temperature measurements were taken every 10 minutes, the reflector was adjusted every 20 minutes, and irradiance data came from the NASA pyranometer on ASU campus. Angled tests were by adjusting the sun oven so that it was perpendicular to the sun, in order to maximize the amount of energy available for transfer.

The flat test was done with the sun oven laying horizontally, as it is shown above.

Geographic Coordinates of Test	36.21° N, 81.68° W
Month	April
Batch size	0.84 liters
Pasteurization temperature	80° C or 176° F
Hours of daylight @ 30° N	12 hours
Average time for full treatment	1.8 hours
Measured efficiency	47.70%
Estimated treated water per day:	5.6 liters