CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)

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Project Number

36556

Project Title

Development of a Household Direct-Steam-Generation Solar-Powered Water Recovery System

Abstract

Objectives/Goals

Access to clean water is becoming an increasingly dire issue worldwide, due to rising populations, industrialization, higher living standards, and localized drought. Solar powered water recovery technologies, utilizing free energy to minimize costs and impact on climate change, are viable solutions for obtaining clean drinking water from desalination of ocean or brackish water or reclamation of greywater or field runoff. This study aimed to design, build, and test a small-scale prototype of a self-regulated, sun-tracking solar powered water recovery system for household use.

Methods/Materials

The design is based on the parabolic trough collector (PTC) technology and has various stages to maximize freshwater output. Temperature was measured using DATAQ digital data acquisition system. An additional study was conducted to refine speed of air flow within the prototype. It was hypothesized a peak in water output would occur at intermediate fan speeds, as lower air speeds would stagnate vapor flow and higher air speeds would provide insufficient time within the condensation stage. A secondary study was conducted by altering fan speeds within the air flow stage via different input voltages. A control with no air flow was used as a point of comparison; mass of freshwater output was measured.

Results

Through multiple design revisions, a final system was created and the engineering goal fulfilled. The apparatus has distinct stages for air and/or water flow: evaporation, air flow, recirculation, and condensation. The hypothesis of the secondary study was supported, as one of the intermediate fan speeds (controlled by 9 volt input) provided maximum freshwater output and results were proved statistically significant. When normalized to the mean vapor pressure of the control, data displayed the same trends and further supported the hypothesis.

Conclusions/Discussion

The engineering goal was fulfilled and a working multi-stage, sun-tracking water recovery system prototype was developed. Furthermore, the maximum freshwater output produced by an intermediate fan/air flow speed, when coupled with the DATAQ-recorded temperatures, indicates a necessary balance between temperature and air flow within the evaporation stage. While the current small-scale prototype will produce over 1 liter of freshwater per day, further refinements and scaling up this design will provide enough drinking water for household use.

Summary Statement

This study aimed to design, build, and test a small-scale prototype of a self-regulated, sun-tracking, solar-powered water recovery system for household use.

Help Received

Father aided in device construction; parents paid for research materials. Gibson's Roofing donated Solatube sheeting; Innovative Insulation provided sample of radiant barrier sheeting. Mr. Peter Starodub provided support throughout the process