CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

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Project Number

35351

Project Title

Studies to Improve the Efficiency of Parabolic Solar Reflector to Boil Water and Desalinate for Drinking and Irrigation

Abstract

Objectives/Goals

My objective was to provide a simple and efficient design of parabolic trough that can be made with inexpensive materials for water desalination/disinfection for regions with water scarcity.
Hypotheses: (i) the wider the parabola the higher the collector temperature (ii) when the parabolic trough is enclosed with a transparent sheet, the collector temperature will be higher.

Methods/Materials

Mylar reflective sheets are attached to table mats (30 cm x 44 cm) and inserted in to three boxes (widths: 27.4 cm, 35.8 cm and 39 cm) to create parabolic reflecting troughs. A copper pipe (1/4th inch. diameter) painted black is used as collector. At the precisely calculated focus for each box, holes are drilled to insert the collector. Thermocouple wire is attached to the center of the collector. An inclined plane tracker ensures the sun#s rays are incident perpendicular to the face of the parabola. For each box, experiments are repeated with box open and the box covered with a plastic wrapping sheet. Temperatures are recorded every 30 seconds, when the collector is heating. Then the trough is closed with an opaque cardboard to block sunlight and temperature readings are taken when the collector is cooling.

Results

When width of the Parabolic trough increased by 42% the initial heating rate increased by 340% and the Maximum Temperature by 153% . The covered trough shows 46C higher temperature compared to the open trough. As predicted by simplified heat transfer equation, measured cooling rate is proportional to the calculated radiation loss using Stefan-Boltzmann law.

Conclusions/Discussion

More reflections focused on the collector in a wider trough lead to higher temperatures. When trough is enclosed, heat loss by air convection is negligible. The most efficient method to make a parabolic trough is to use a wide parabola and enclose it with a transparent plastic sheet. For an enclosed parabola of 39 cm width, the collector reached over 200C # which can readily boil water. Inexpensive materials (<$5) can be used to make the solar trough, collector and tracker. This method can be used to produce fresh drinking water in regions of the world where there is physical or economic water scarcity. Such alternate methods of water generation are crucial to meet world#s growing water need.

Summary Statement

Parabola width increase of 40% can result in heating efficiency increase of 340%, with collector reaching 200C, enough to readily boil water.

Help Received

My dad helped to calculate focus for each parabola width and design the inclined plane tracker, and to compare experimental results with heat transfer model.