Abstract
Sterilization of surgical instruments is required to prevent infection and the spread of disease. Common sterilization methods require electricity, however rural clinics in developing nations often do not have access to dependable electricity. These clinics are responsible for providing healthcare to three billion people worldwide, nearly half the world population [1].

This project consisted of the design and fabrication of a compact, user-friendly, and high quality solar sterilization system. The system consists of an evacuated tube solar collector set at the focal point of a parabolic reflector. A micro-controller tracks temperature and displays sterilization status. Also accommodated in the design is a regular AC power option for when access to electricity is made available.

The system effectively sterilizes surgical instruments under dry heat in accordance with the guidelines of the Centers for Disease Control (CDC).

Project Goals
The goal of this project was to create a functioning, complete, and production-ready prototype of a solar-powered sterilizer.

The minimum requirement of the design was the ability to sterilize surgical instruments in line with the guidelines set by the Centers for Disease Control (See "Requirements for Sterilization"). Beyond this minimum requirement, there were a number of other desirable goals:

- Portability - The system should be able to be carried and deployed by one person
- Ease of Use - A maximum of one hour of training is required for a person to learn and understand the operation of the system
- Dual Energy - The system should be able to operate with energy from the sun, or energy from the power grid

Requirements for Sterilization
High temperatures over a particular period of time kills microbes and pathogens, sterilizing whatever object is held under those conditions. The Centers for Disease Control (CDC) maintain guidelines for sterilization of surgical instruments with specific lengths of time for a few different temperatures. For dry-heat sterilization, instruments must be subjected to temperatures of 170°C for 60 minutes, 160°C for 120 minutes, or 150°C for 150 minutes [2].

Solar Heating Design
The solar heating design revolves around two key components: an evacuated tube solar collector and a parabolic reflector. These are paired together to transfer the sun’s energy with maximum efficiency.

An evacuated tube solar collector is very similar to a thermos: it has a double glass wall with an insulating vacuum between the layers. The outer layer is clear, to allow the sun’s radiation through, while the inner layer is coated with a black absorbing layer. The solar radiation is absorbed by the black layer and trapped by the vacuum, which results in the interior of the tube heating up and holding the heat in.

The parabolic reflector focuses the sun’s rays on a single point, the focal point. The evacuated tube is placed at the focal point, amplifying solar radiation on the tube.

Solar Collector
- Evacuated tube solar collector absorbs solar radiation and utilizes a vacuum layer to keep heat in
- Solar panels power the control panel
- Parabolic reflector reflects sun rays to the evacuated tube

Insert
- Surgical instruments are placed in the insert, then insert goes into solar collector
- Control panel allows user to initiate sterilization and LCD displays temperature and time until sterilization is complete
- Interface between electronic housing and instrument tray is made of stainless steel and filled with fiberglass insulation to prevent conduction of heat out of the sterilizer

AC Heating Design
A project goal was to ensure that the solar-powered sterilizer remains useful even after its owners gain access to reliable electricity. AC heating is far more powerful and efficient than weather-dependent solar heating. With this in mind, an electric heating system was included. This system allows the sterilizer to be used indoors with AC power.

The AC heating system consists of a resistance heating element and an optically isolated solid-state relay. The relay is interfaced with the micro-controller to turn on when the temperature inside the tube is lower than necessary for sterilization, and turn off when above the required temperature. This simple temperature control system maintains the internal heat at the required sterilization temperature until complete.

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References