SOLAR WATER STERILIZATION DEVICE

Developing an innovative and inexpensive water pasteurization device for Haiti

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THE DEVICE

Fig. 1. Water temperature vs. residence time needed for safe water pasteurization.

Fig. 2. Average daily solar irradiance (W/m²-K) for Haiti (lat. 19°) and Oregon (lat. 45°) determined by scaling average daily irradiance at lat. 40.5°. Cumulative purified water volume represents predicted daily yield at a water flowrate of 150 mL/min, assuming operation at peak hours (10:00-16:00).

Fig. 3. (A) Device Schematic. Water flows from a cold reservoir, is preheated by the heat exchanger (HX), is heated in the solar box, re-enters the HX to pre-heat inlet water, and collects in a reservoir. (B) Prototype. The 3’x4’ solar box has 3 reflectors to maximize UV reflection into the box. Water flows through 100 ft of PEX tubing mounted on a 3’x4’ steel plate and is sealed with a solar window (clear plastic sheet) to prevent heat loss.

Fig. 4. Steady state water temperature (°C) exiting the solar collector vs. water flowrate (mL/min). Two successful trials were completed at 150 mL/min. Error bars represent the standard deviation. Additional replicates will be done to determine the optimal flowrate.

Fig. 5. Length of PEX tubing (ft) needed for water to reach desired outlet temp (°C). The overall heat transfer rate of the box (UBox) was found by $Q_{tot} = mc_\text{water}\Delta T = U_{box}\Delta T_{inlet}$ and length was found by area (A).

BACKGROUND
- Waterborne illnesses cause over 50% of deaths in Haiti.¹
- Captured water must be sterilized. Common methods are chemical (e.g., bleach), thermal (e.g., pasteurization), or radiation (e.g., solar disinfection).
- Sunlight is abundant in Haiti.
- Continuous-flow systems are more efficient than large batch systems for heating water.
- Use UV radiation to treat 150 L H₂O per day.

OBJECTIVE
Use UV radiation to treat 150 L H₂O per day.

Table 1. Material list for the solar device & HX, along with purchased costs & projected unit cost after bulk production.

<table>
<thead>
<tr>
<th>Material</th>
<th>Dimensions</th>
<th>Quantity</th>
<th>Cost (USD)</th>
<th>Bulk Cost (USD)</th>
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<tr>
<td>Solar Collector</td>
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<td>Plywood</td>
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<td>PE Tubing</td>
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</table>

H₂O in PET bottles: 32 °C for 5 hr.²

REFERENCES
[1] Pan American Health Organization, 2010

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- Dr. Alex Yokochi, project sponsor
- Justin Pommereck, graduate mentor
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- Jim Ervin, providing outdoor testing space
- Andy Brickman, technical help & supplies
- CHE 416 solar teams, supplies & collaboration
- Dr. Philip Harding, project advisor

FUTURE WORK & CONSIDERATIONS
- Synergistic Heating (device = preheater)
- H₂O in PET bottles: 32 °C for 5 hr.
- Water Pasteurization Indicator (WAPI)
- Adaptation to Haitian Culture
- Increase HX & PEX tubing length to improve performance and purity 150 L/day
- Publish plan in Journal of Humanitarian Engineering. It design is accepted, the complex components (e.g., HX) could be built domestically in bulk and shipped to Haiti.