Solar Powered Water Purification

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Project Description/Justification

The goal of the project is to create a portable solar-powered water purification device that can purify 10 gallons of drinking water per day using distillation.

Hooking up to a pre-existing above ground water source found in the target area of Rwanda, the water is filtered in a three-stage filter, before entering a heating basin. In the heating basin, the water is boiled, and the steam exits the heater into the condenser. The copper condenser coil is submerged in a flowing bath that cools the coils allowing the steam to condense into distilled water. The distilled water is collected in a basin that has a spout, allowing the user to dispense the water when needed.

This method is very cost-effective compared to drilling a well and will provide quick, clean and safe drinking water for areas which have a shortage. The intention of the project is that a non-profit organization purchases multiple devices so they can be donated to villages in Rwanda, or wherever there are drinking water shortages.

Functional Design Requirements

Solar Powered
- 1.5kW solar panel array
- 12V, 3000Ah battery – IEEE/ASHRAE 1635-2018
- ASTM E1056-85

Provides 10 Gallons of Drinking Water
- Three-stage filter (> 0.2 microns in diameter)
- Purified through distillation
- Follows government standards (EPA, FDA, Rwandan Board of Standards)

Pump Requirement
- Pump water 4’ vertically into the heating basin
- Powerful enough to pump water through the 0.2-micron filter at a reasonable rate
- Constant flow of water into condenser basin
- Water must be stored and dispensed at user's discretion

Maintenance/Use
- Device is enclosed but also serviceable
- Locking latches allow for battery access
- Hinged doors allow access to internal components
- Protect the users from any excessive discharges of heat using insulation
- Removable heating basin lid, filter, distilled water basin allows for sterilization/cleaning

Pre-Existing Water
- Water will not be sourced as a functional requirement of this project, only for testing purposes in the US.
- Standard connection allows typical garden hose to be used

Portability
- Trailer mount allows the user to move it easily with two people when empty

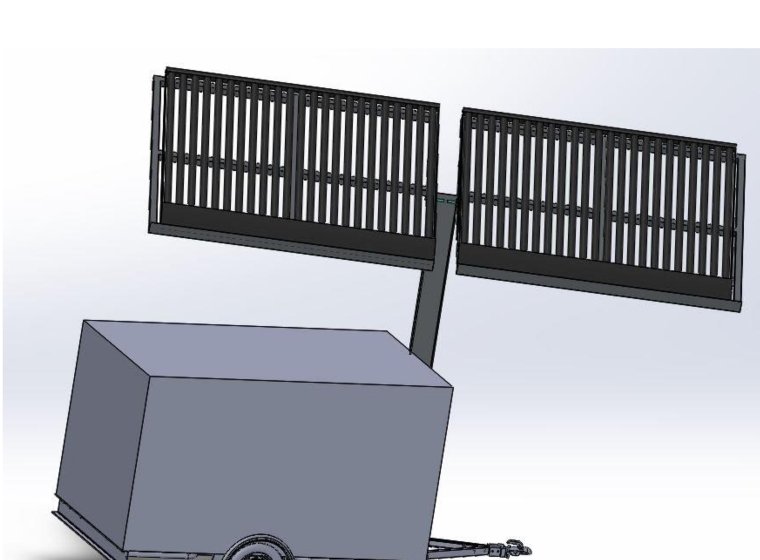

Figure 3

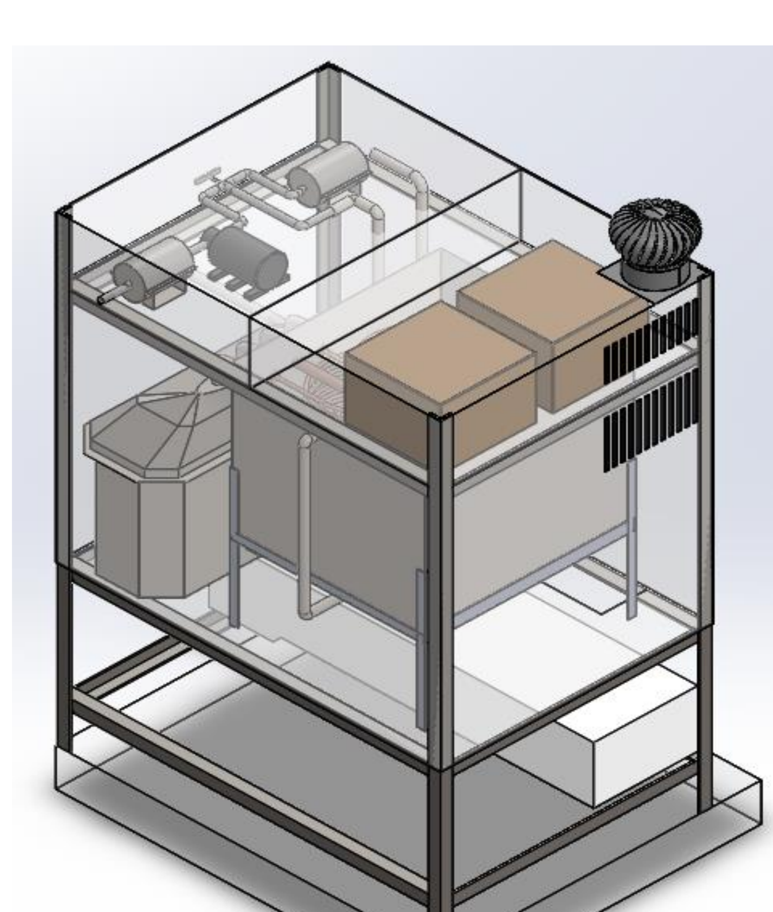

Figure 4

Design Process

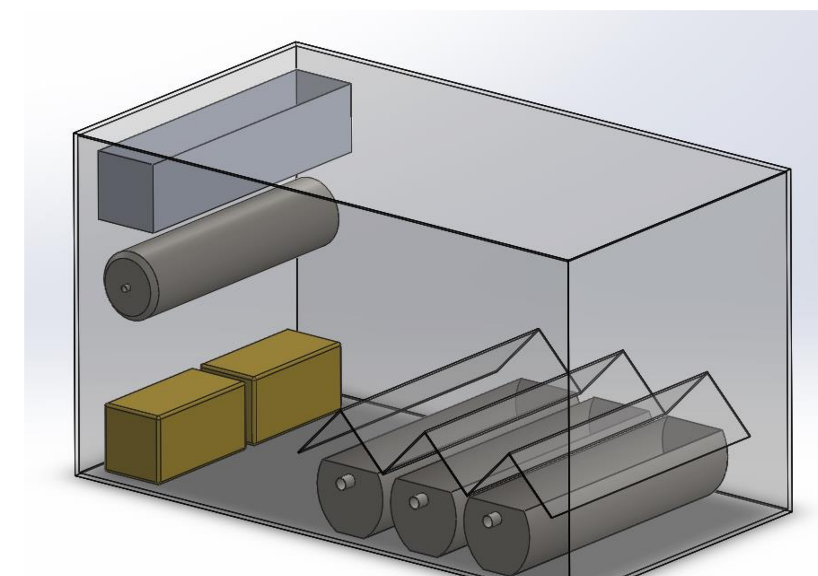

Figure 1

The initial design demonstrated in Figure 1 was intended to have a seed filtration phase to purify the water before distillation. The batteries were located inside the system and the flow of water was not taken into consideration. The cylinder-like basins acted as the boiler. The design used triangle-like condenser plates that had to be electrically cooled. This design was not safe for the customer, was not power efficient, and diverted from the functional requirement which stated that the system must use natural water cycles to purify the water.

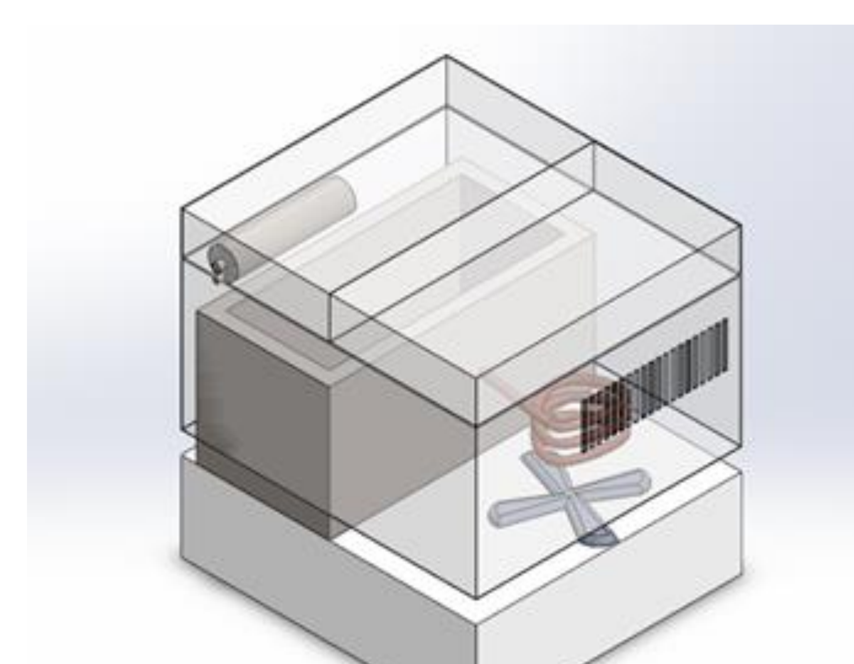

Figure 2

The second design demonstrated in Figure 2 was an improvement because it would have consumed less power. The water was condensed using a fan and copper coil that carried steam from the boiler. Vents were added to this design to circulate cooler air for the condensation process to occur. However, the coil was very small in diameter, which risked high pressure build up. The sharp edges of the boiler presented the possibility of bacteria building up in the corners, making it difficult to maintain. This would be violating the functional requirements which stated that the system must be easy to maintain. Although less total power was required to run the system, relying on a fan to condense the steam was a risk because the fan may not be efficient enough to produce enough water.

The final design changes demonstrated in figure 3 and 4 were made to mainly improve power efficiency, decrease bacterial build up and improve the safety of the system. To improve power efficiency, a separate basin was added to assist in the condensation process. This basin will store cold water from the main water tank and will have copper pipes submerged into the basin to cool the steam. Once the water in the condensation basin has increased in temperature, it will be poured into the main boiler for distillation. This product decreases the amount of power needed to boil the water since the water will be preheated. The final design has more round edges to decrease the build up of bacteria in the corners. To further improve the safety of the product, proper ventilation was added to cool the batteries and the whole system.

Although no testing was performed, the solar panel efficiency and potential power able to be collected would have been essential in determining if the system would work properly. Once properly connected, the solar array, batteries, heating element and pumps would have been tested to ensure enough water is being produced and the water quality is up to the government standards.

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