Solar Desalination Using a Fresnel Lens

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Abstract

- Lack of access to clean drinking water is an immediate issue that needs to be addressed
- Goal: Build a cost effective and efficient solar desalination model that can bring clean drinking water to families in need
- What we did:
  - Devised a blueprint of our portable solar desalination model
  - Estimated ideal spigot flow rate, rate of evaporation, and hypothetical water production rate for a family of four-five
  - Tested and gathered hard data of time and temperature of water under fresnel lens
  - Discovered how our small-scale, fresnel-lens-incorporated desalination model can effectively produce a substantial amount of drinking water to countries in need

Intro

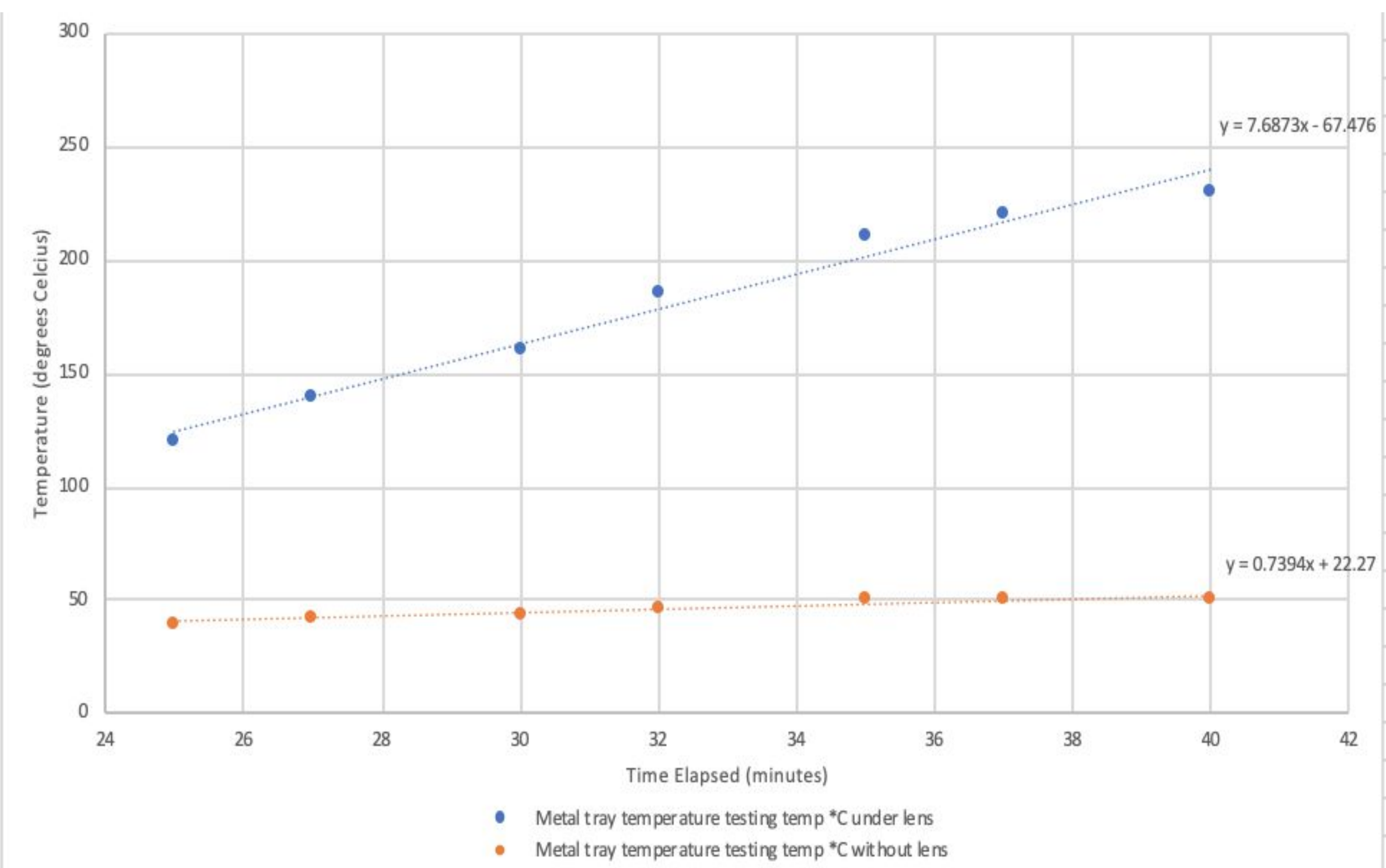
- As of 2019, over 1 billion people lack access to clean drinking water and this number is bound to increase.
- Our challenge: Create a novel desalination model that is more cost effective and efficient than current solutions.
- Why our solution is important: Our model's portability, design, and fresnel lens incorporation is unique and shines new light on a new possible method to increase access to drinking water.
- Before testing, we calculated our estimated flow rate to be **0.03mL/min** using software

Methods

- ***Metal Tray:*** placed metal tray 1 in the sun (control), placed metal tray 2 under the lens, and evaluated differences in heating rates and maximum temperatures
- ***Water Droplet***: focused lens and immediately placed a drop of water on ambient temperature metal tray, and observed evaporation time
- **Water Pool:** heated 0.5oz of water placed on a metal pan using fresnel lens for 10 minutes and collected data and how much water was evaporated
- **Heat Soak**: measured heat soak and temperature drop when different amounts of water (0.5, 1, and 2mL) were dropped onto a metal pan at different temperatures (each test done separate)

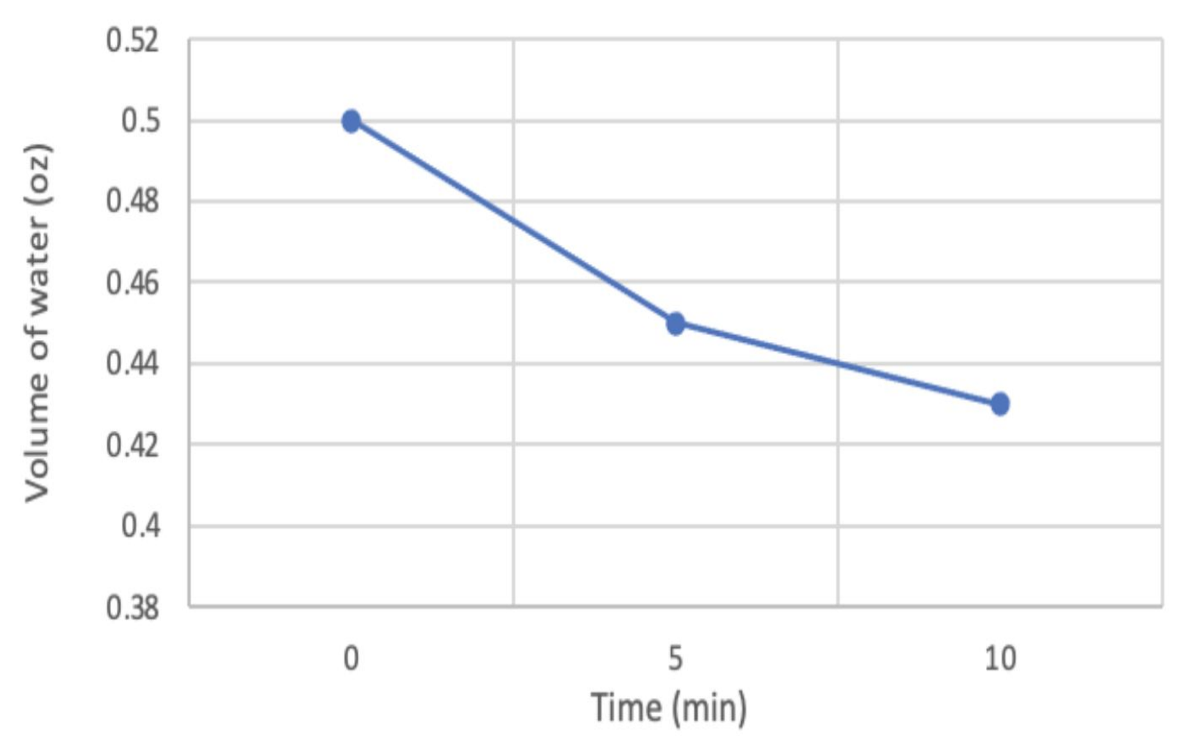
Results

Metal Tray- With and Without Lens



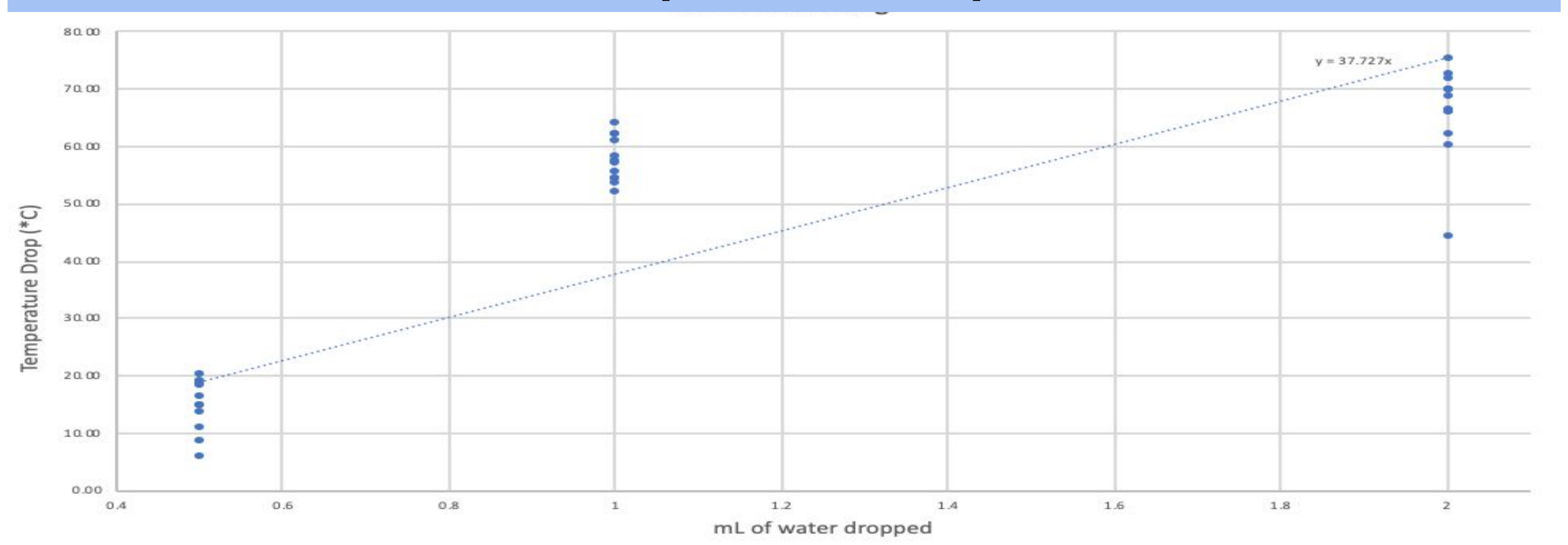
- Tray 1 alone heated up at a rate of **0.7*C /minute** and remained around **55*C** after the first 10 minutes
- Tray 2 under the lens heated up at a rate of **7.7 *C/minute** to a peak temperature of **230*C** after **38 minutes**

Water Pool Evaporation



- Volume of water evaporated from 1.5 mL pool under fresnel lens in 10 minute time interval
- From a pool, the average evaporation rate was **0.03 mL/minute**

Heat Soak- Temperature Drop from Water



- We expect temperature to dop **37.73*C** with every **1mL** of water added to the pan

Water Droplet- Evaporation

- The average time for a drop of water to evaporate (*from ambient temp*) under the lens is **86.8 seconds**
- Estimated **dripping evaporation rate is 0.001 oz/min** (from **0.05mL/86.8sec**)

Conclusions

- Ideal temperature range: **176-230*C**
- Flow rate was found to be **1mL per minute.**
  - *Compared to previous synthesized estimate of full scale model (0.03 mL/minute)*
- The 0.5 mL drops were most efficient at reducing heat soak.
- 5 min to recover from 1mL dropped onto the pan
- If add 1 mL of water, temp will drop to 192*C, and take 5 minutes to heat back up to 230*C
- How much drip in a day: avg 5.67 hours minimum of peak sunlight, -0.67hr taken for initial warm up, leaving **5 hours of water production,** produces:
  - **60mL/day** of clean water through drip (conservative estimate with the scaled down model)
  - *Compare to pool evaporation rate:* ***9mL/day***
  - *Compare to single drop rate from ambient temp:* ***10.7mL/day***
- *Next steps*: building the rest of the model and experimenting with shape best for water vapor capture, then scaling up with a larger scale model

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Citations

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