DEPARTMENT OF MECHANICAL ENGINEERING

Under Pressure - Team D6
Small-Scale Desalination

Leo Brower, Sergio Cuaresma, Mason Esptein, William Maguire, Andre Marques, Joshua Wang

A. JAMES CLARK SCHOOL OF ENGINEERING

Motivation, Goal, Impact

Motivation:

- **0.5%** of Earth's water is accessible freshwater
- Coastal regions like Haiti **lack infrastructure to treat saltwater**

Desalination Plant (Ras Al Khair).

✗ Too expensive
✗ Energy intensive
✗ Environment impact

Goal:

- **Low-energy, portable** desalination system
- **5 L/day** of potable water

Impact:

- **Clean** water for off-grid coastal communities
- **Renewable** solar-thermal energy
- **Daily household** use, **humanitarian relief**

Requirements

HIGH

LOW

Produce 5 Liters of drinkable water per day

Small scale (mass < **10 kg**)

Energy efficient (zero electricity)

Easy to **operate** (startup in < **10 min**)

Easy to **clean, maintain,** and **repair**

Environmentally friendly

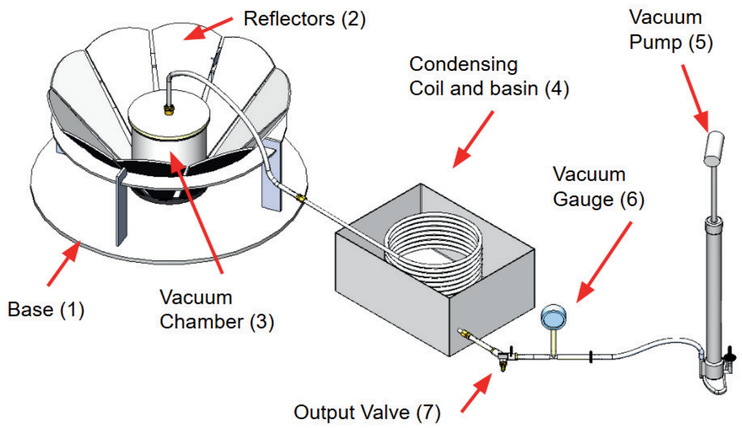
Durable and **corrosion-resistant**

Affordable (under **$300**)

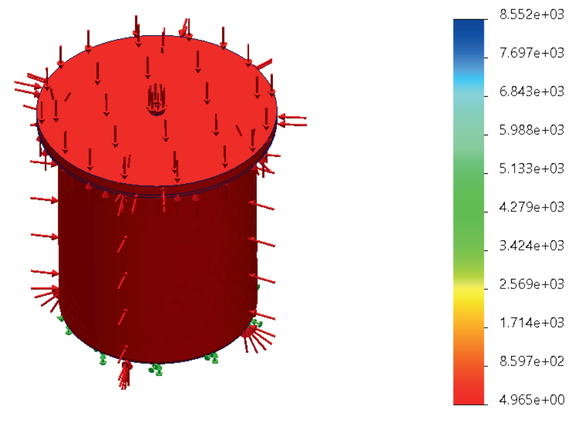
Manufacturable

Final Design

Vacuum-Sealed Solar Distillation Desalination Device



Complete labeled diagram of all the subsystems.



Final design FEA analysis for safety factor.

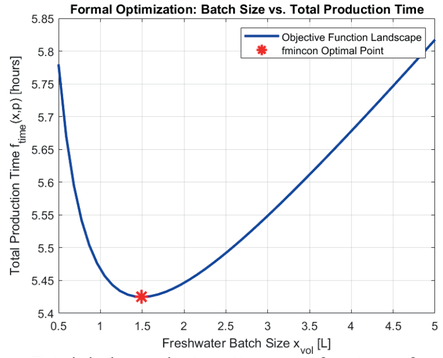
Pros

- **Easy** to operate, clean, & maintain
- ***Small*** *Scale*
- ***Zero*** *electricity usage*

Cons

- Existing solutions outperform our design
- **High** cost to manufacture

Design Calculations & Decisions



Total daily production time as a function of freshwater batch size.

- **Vacuum: 20.7 kPa**
- **Batch Size: 1.5 L**

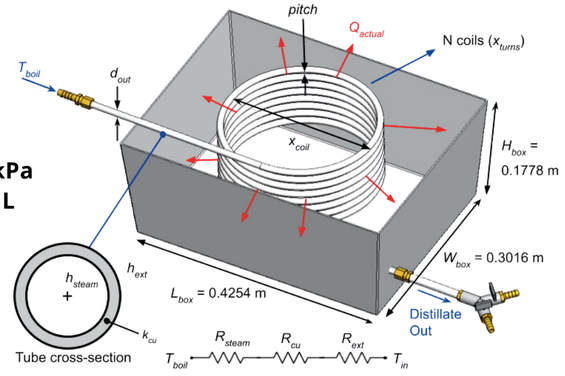
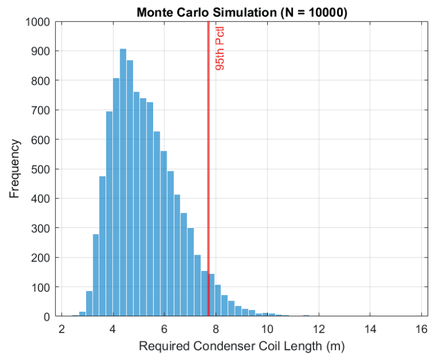


Diagram of the helical condenser coil and basin.



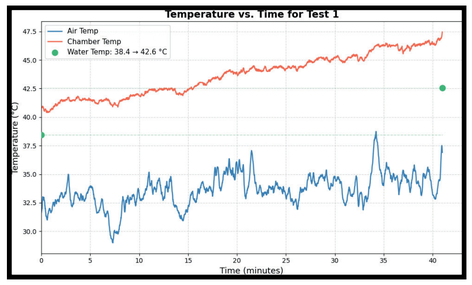
Monte Carlo simulation for the condenser.

Analysis Type	Condition	Req. Condenser Length	Confidence
Deterministic	Nominal Haiti Weather	5.88 m	~50%
Monte Carlo	95th Percentile	7.71 m	95%
Final Design	Rounded for Manufacturability	**7.75 m**	> 95%

Prototype & Test Results

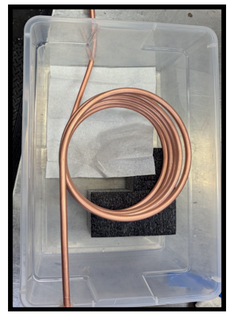
Full prototype

Pressure Gauge at 22'' of mercury

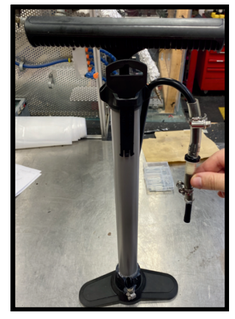


Thermistor data from testing

Boiling chamber



Condensor



Reverse bike vacuum pump