NOOOOO!!!!! YOU CANT BOIL WATER WITHOUT A NORMAL FUEL SOURCE!!! YOURE DESTROYING THE NATURAL ORDER!!!! YOU NEED MY COAL FIRED STOVERINO NOOOOOO

haha solar cooker go brrrr

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Question

Design - What is the ideal pot material and smallest mirror diameter for a parabolic solar cooker to raise the temperature of two liters of water from 20°C to boiling in 5 minutes?

- Specifically useful for people who live in areas without access to traditional fuels
- Could give indications of how to optimize existing designs without access to physical tools
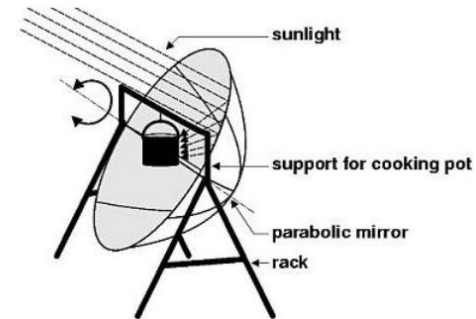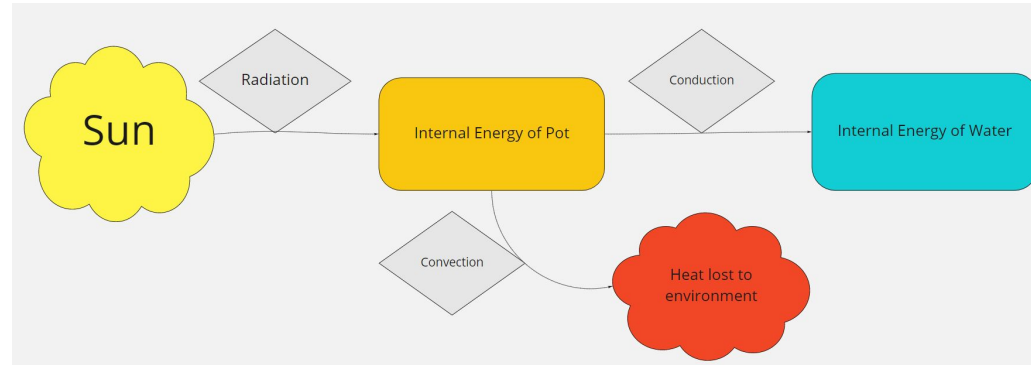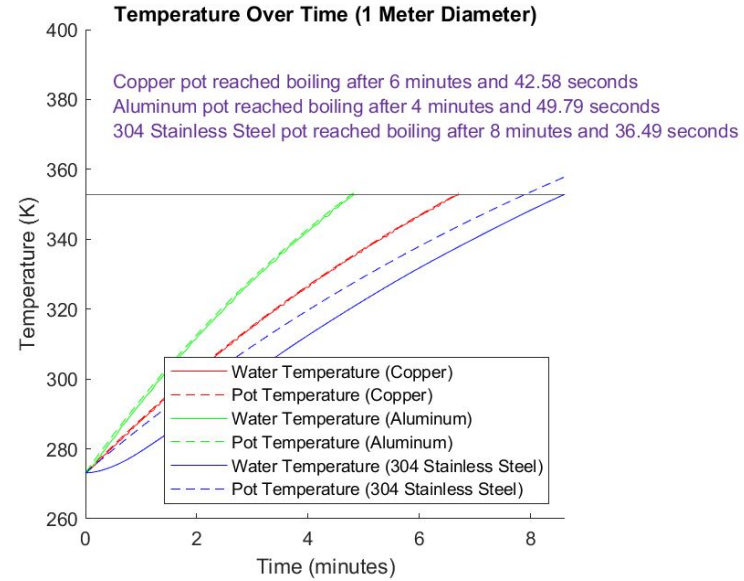
Model

Parameters:

- Himalayas, solar noon, Jan 1, high wind
- Difficult but realistic conditions
- Copper, Aluminum, and 304 Stainless Steel Pot

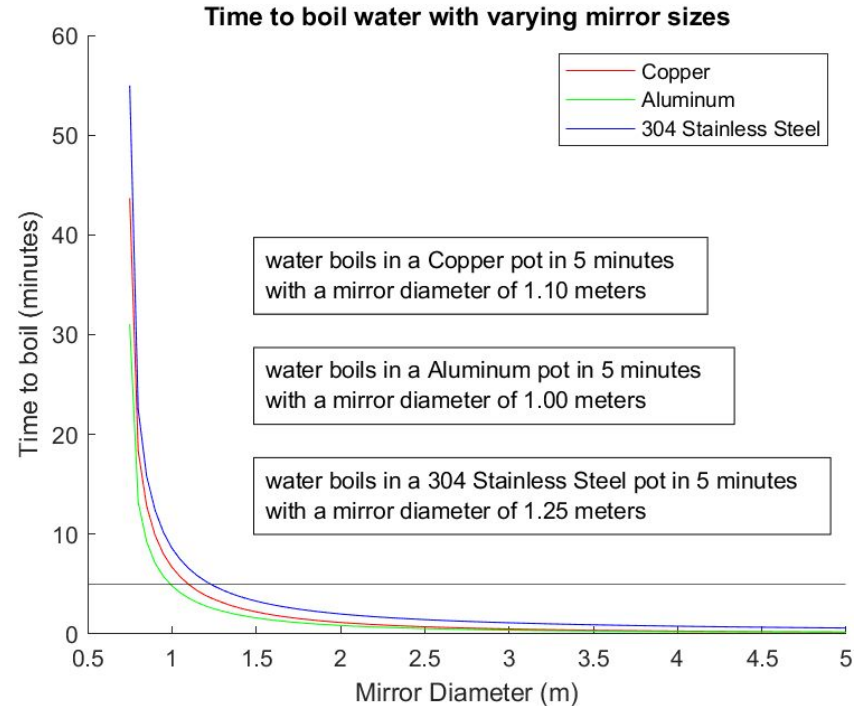$$\frac{dQ}{dt} = eIA \quad \textit{(flow of radiation from sun to the mirrors/pot)}$$

$$\frac{dQ}{dt} = \frac{kA}{d\Delta T} \quad \textit{(flow of conduction from pot to the water)}$$

$$\frac{dQ}{dt} = hA(T_{air} - T_{pot}) \quad \textit{(flow of convection from pot to the air)}$$

Temperature Over Time (1 Meter Diameter)

Copper pot reached boiling after 6 minutes and 42.58 seconds
Aluminum pot reached boiling after 4 minutes and 49.79 seconds
304 Stainless Steel pot reached boiling after 8 minutes and 36.49 seconds

Legend:
- Water Temperature (Copper)
- Pot Temperature (Copper)
- Water Temperature (Aluminum)
- Pot Temperature (Aluminum)
- Water Temperature (304 Stainless Steel)
- Pot Temperature (304 Stainless Steel)

X-axis: Time (minutes)
Y-axis: Temperature (K)

Diagram:
Sun → Radiation → Internal Energy of Pot → Conduction → Internal Energy of Water

Internal Energy of Pot → Convection → Heat lost to environment

Results

- Aluminum is the best material for our application (highest conductivity!)
- Mirror diameter of 1 meter is sufficient to boil water in < 5 minutes

Time to boil water with varying mirror sizes

Legend:
- Copper
- Aluminum
- 304 Stainless Steel

water boils in a Copper pot in 5 minutes with a mirror diameter of 1.10 meters

water boils in a Aluminum pot in 5 minutes with a mirror diameter of 1.00 meters

water boils in a 304 Stainless Steel pot in 5 minutes with a mirror diameter of 1.25 meters

Time to boil (minutes)

Mirror Diameter (m)

Interpretation

- Our results directly answer our question: an aluminum pot can boil water in 5 minutes with a 1 meter diameter mirror
- A good solution to our problem, but very location specific
- Possible limitations to take in account other independent variables
    - Location
    - Time of year
    - Time of day
- Accounting for more parameters would make our information about specific boiling times and diameters more accurate.

Resources

Miro Board Link: https://miro.com/app/board/o9J_kg0-7nE=/

Copper and Aluminum Properties: https://www.periodic-table.org

304 Stainless Steel properties: https://www.aksteel.com/sites/default/files/2018-01/304304L201706_1.pdf

Intro to Thermal Packet: https://olin.instructure.com/courses/138/files/10240/

Solar Insulation Calculator: https://www.pveducation.org/pvcdrom/properties-of-sunlight/calculation-of-solar-insolation

Mount Everest Temperature Data:
https://www.meteoblue.com/en/weather/historyclimate/weatherarchive/mount-everest_nepal_1283416

Water Boiling Point vs. Altitude: https://www.engineeringtoolbox.com/boiling-points-water-altitude-d_1344.html