Solar Stove

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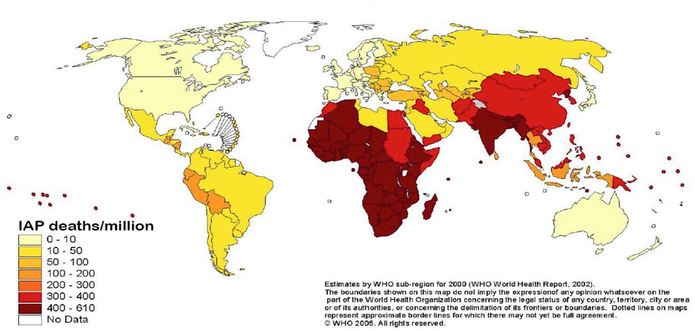
Motivation



The World Health Organization estimates indicate 4.3 million deaths in 2012 due to indoor air pollution from biofuel cook stoves, about 8 deaths per minute.

Our group is motivated to create an alternative cooking method that will help prevent millions of death from indoor air pollution by using cleaner cook stoves.

Goal

To develop a solar cook stove with energy storage capabilities that fulfills and meet current cooking requirements.

Objective

To complete and improve upon current solar stove's design.

Solar Collector → Transfer to Storage → Storage → Transfer To Food

Requirements and Constraints

Requirement	Value
Total Cost	$40 USD
Weight of Solar Stove	25 lb
Cooking Surface Temperature	200 C
Coking Surface Heat	1000 W
Cooking Surface Area	201.0619
Daily Cooking Time	4 hours
Recharge Time	4 hours
Daily Storage Time	18 hours
Life span	10 years
Maintenance	None

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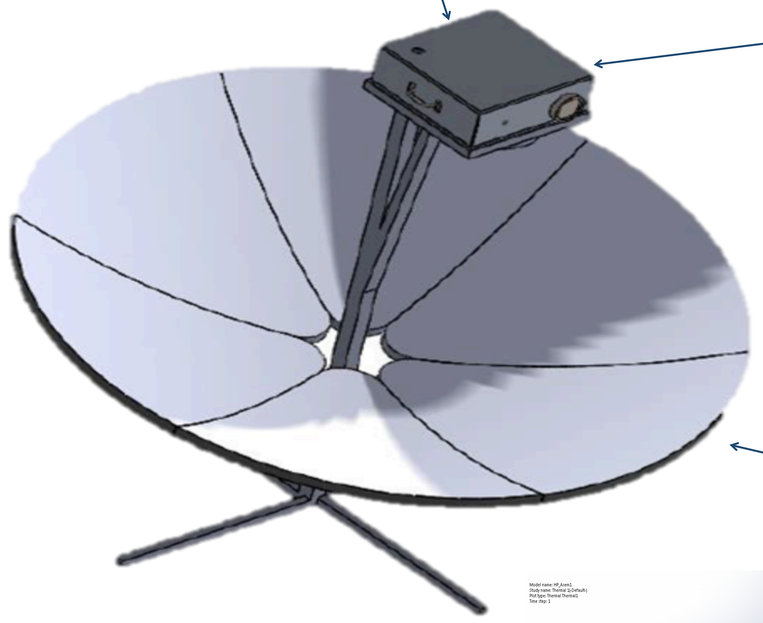
Storage

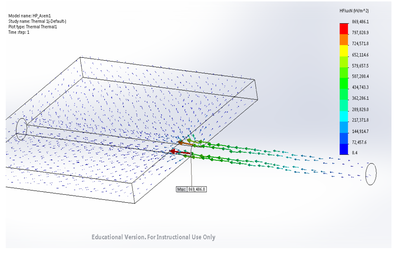
To obtain an ideal heat loss of less than 5% in 8 hours from the salt vessel to the surrounding environment.

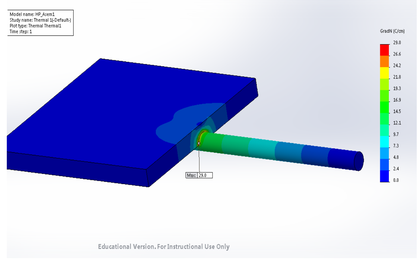


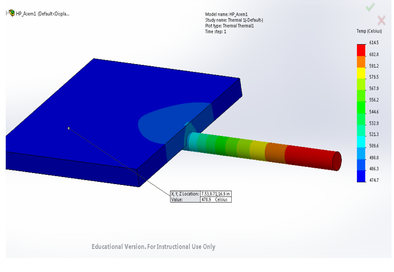
Thermal Heat Pipe

Optimize current thermal fin and research possible application of heat pipe in a cook stove.

The thermal fin is the medium by which thermal energy from the salt is transported to the cooking surface.







Salt Vessel Understanding

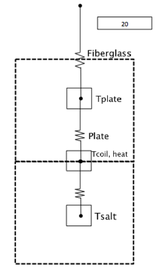
$Q = mh_{S_L}$
h_{S_L} = Phase change heat capacity
$Q = l_h + S_L$
l_h = latent heat
S_L = Sensible heat

$$Q_{salt} = \rho V h_{S_L} + c_p \rho V \Delta T$$
$$Q_{conv} = hA\Delta T$$
$$\dot{Q}_{alm} = \frac{\Delta T}{R} = \frac{4\pi k r_1 r_2 \Delta T}{r_2 - \square_1}$$

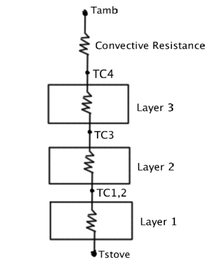
Theoretical Total amount of time to Charge:
$\dot{Q} = Q_{alm} + Q_{insulation} + Q_{salt}$
$\dot{Q} = 5669724.939 \text{ Joules} + 732.9 \text{ Joules} + 6{,}450{,}000 \text{ J}$
$\dot{Q} = 12120457.84 \text{ Joules} = 3.367 Kw - hr$

Total time with 320 Watt Burner= 10.52 hours
Total time with 1KW Dish= 3.367 hours

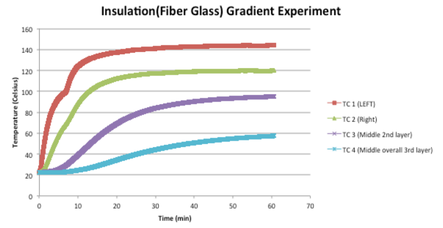
Thermal Circuit Model



Thermal Model Circuit- Multi-level insulation



Insulation(Fiber Glass) Gradient Experiment



Solar Collector Build and Experimentation

Outcome:

Salt vessel took 2 hours to reach maximum capacity at 450F under perfect Californian sunshine.
It took 10 minutes to cook 5 eggs with a lid-covered pan.
Cooking Surface Temperature = 350C
Power Output from Solar Collector = 21.41 kW