Beam Sizing Sizing Calculations

$$q = \frac{-k(T_B - T_H)A}{\Delta x}$$

Used for calculating heat loss on the rod section that penetrates the stove wall

$$M^2 = \frac{hP}{kA_c}$$

$$q = M tanh(mL_c)$$

Adiabatic tip condition for fin calculation, used in sizing the heat harvesting devices

$$m = \sqrt{hPkA_c} * \theta_b$$

$$L_c = L + \delta$$

Corrected length to account for area of the fin tip

$$\delta = \frac{t}{2}$$

Factor for corrected length

$$R = \frac{(T_b - T_\infty)}{q}$$

Thermal resistance equation used to back out size feasibility

$$R = thermal\ resistance$$

$$k = thermal\ conductivity\ constant$$

$$h = heat\ transfer\ coefficient$$

$$P = perimeter$$

$$A_c = cross\ sectional\ area$$

$$\theta_b = temperature\ difference$$

$$\theta_b = T_b - T_\infty$$

$$q = 130w$$

$$h = 30.2\ \frac{w}{m^2 * K}(Fire)$$

$$T_H = 300℃$$

$$k = 51.2\ \frac{w}{m * K}(Steel)$$

$$T_\infty = 900℃$$

$$T_H = temperature\ of\ TE\ hot\ side\ interface$$

$$q = heat\ energy\ transfered$$

To size our thermal energy harvesting apparatus we assumed adiabatic tip condition and moved forward. This assumption allowed for the base equation to be used in our analysis. To start, the heat loss through conduction in the section between the inner and outer stove was calculated assuming perfect insulation allowing us to find a temperature at the inner wall needed to maintain a 300 degree Celsius temperature at the thermal electric. The temperature at the stove wall was used to size out ruler shaped steel beam to conduct the heat energy into the thermal electric. Using Matlab a program was constructed to first calculate the temp at the inner wall of the stove and them vary both length of the beam and width given a user defined thickness. This allowed the optimum sizes to be obtained for each individual length.

Final Beam Sizing: 0.5” X 2.75” X 6.94”