Producing Light from Stoves using a Thermoelectric Generator

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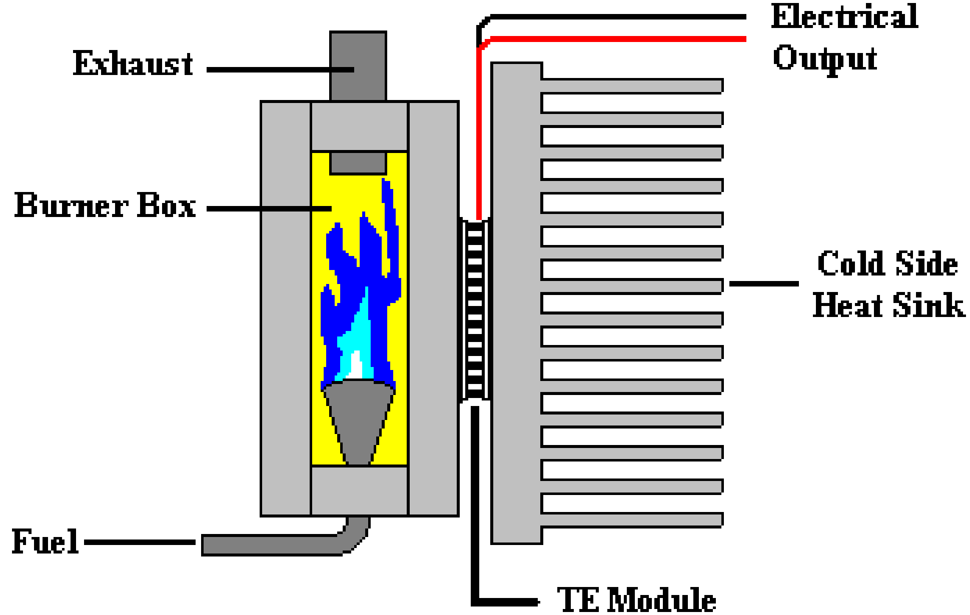
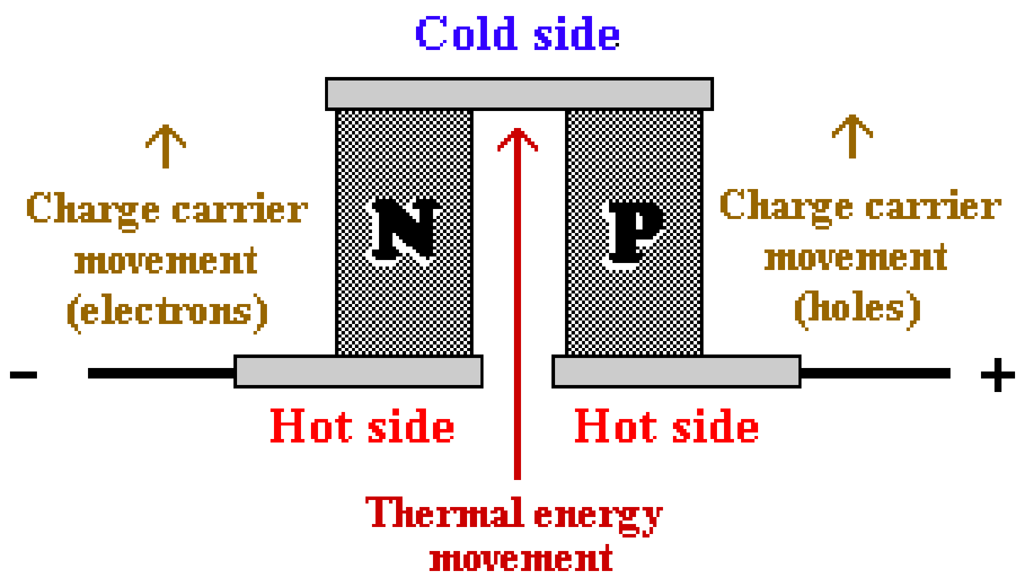
Thermoelectric Power Generation

- Thermoelectric generators produce electricity directly from the flow of heat
- Silent operation
- No moving parts



Theory of Operation

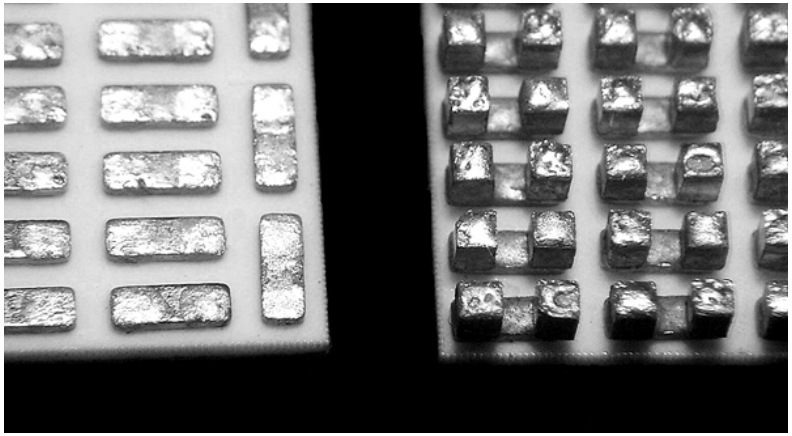


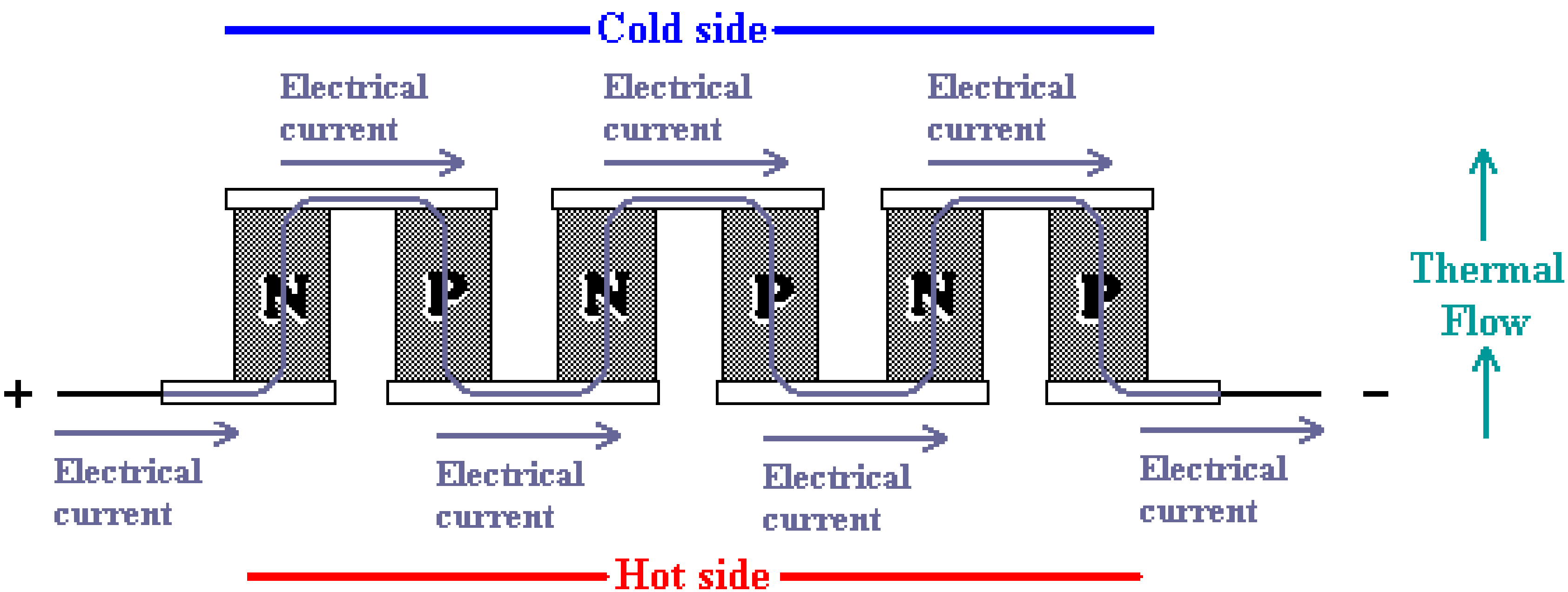
- Electrons on the hot side of a material are more energized than on the cold side. These electrons will flow from the hot side to the cold side. If a complete circuit can be made, electricity will flow continuously.

- Semiconductor materials are the most efficient, and are combined in pairs of "p type" and "n type". The electrons flow from hot to cold in the "n type," While the electron holes flow from hot to cold in the "p type." This allows them to be combined electrically in series.

Theory of Operation

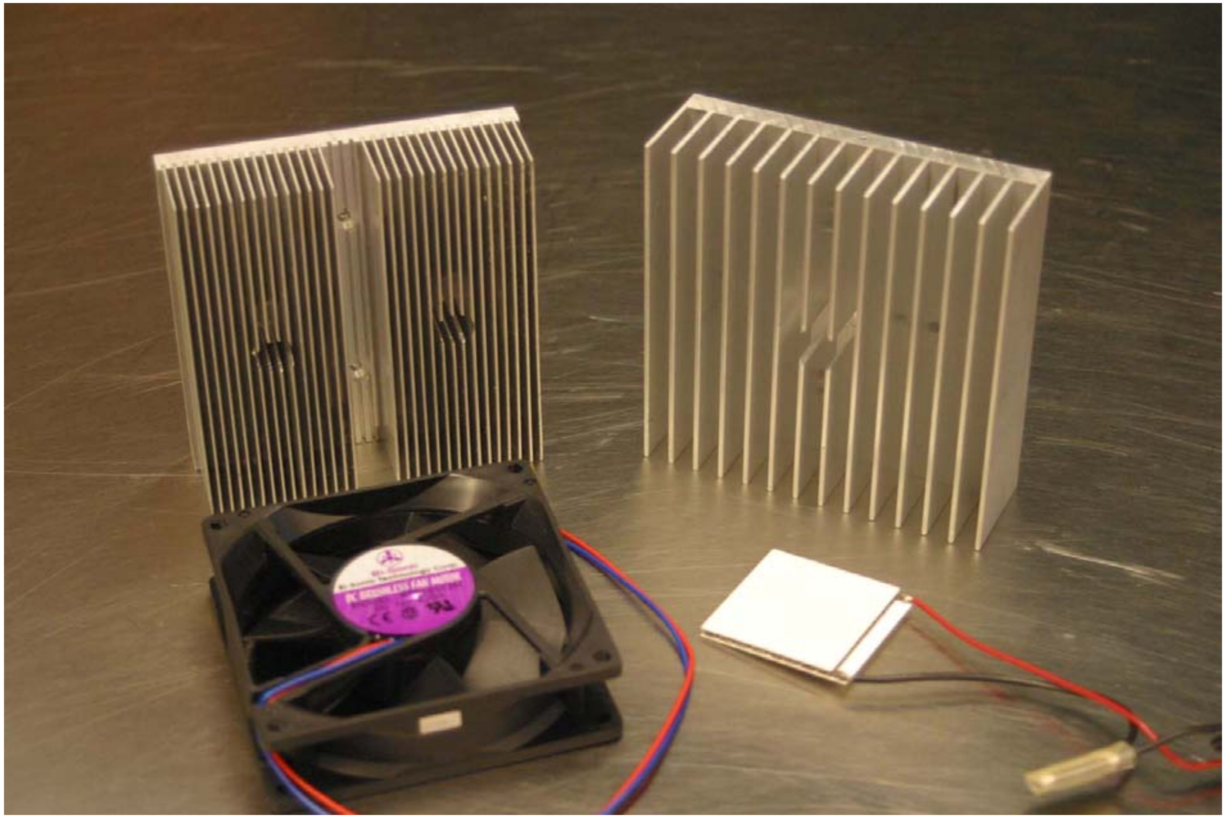
Elements are combined in series to increase voltage and power output





System Components

- A thermoelectric generator requires the following components:
  - Hot sink
  - Module
  - Cold sink
  - Cooling fan (Optional)
  - Power circuit



Module Selection

- A high temperature bismuth telluride module has been selected due to its high efficiency and high operating temperature
- 4% efficiency
- 5.9 Watts @ max power
- $10 in large quantity (10,000+)

Cold Sink Selection

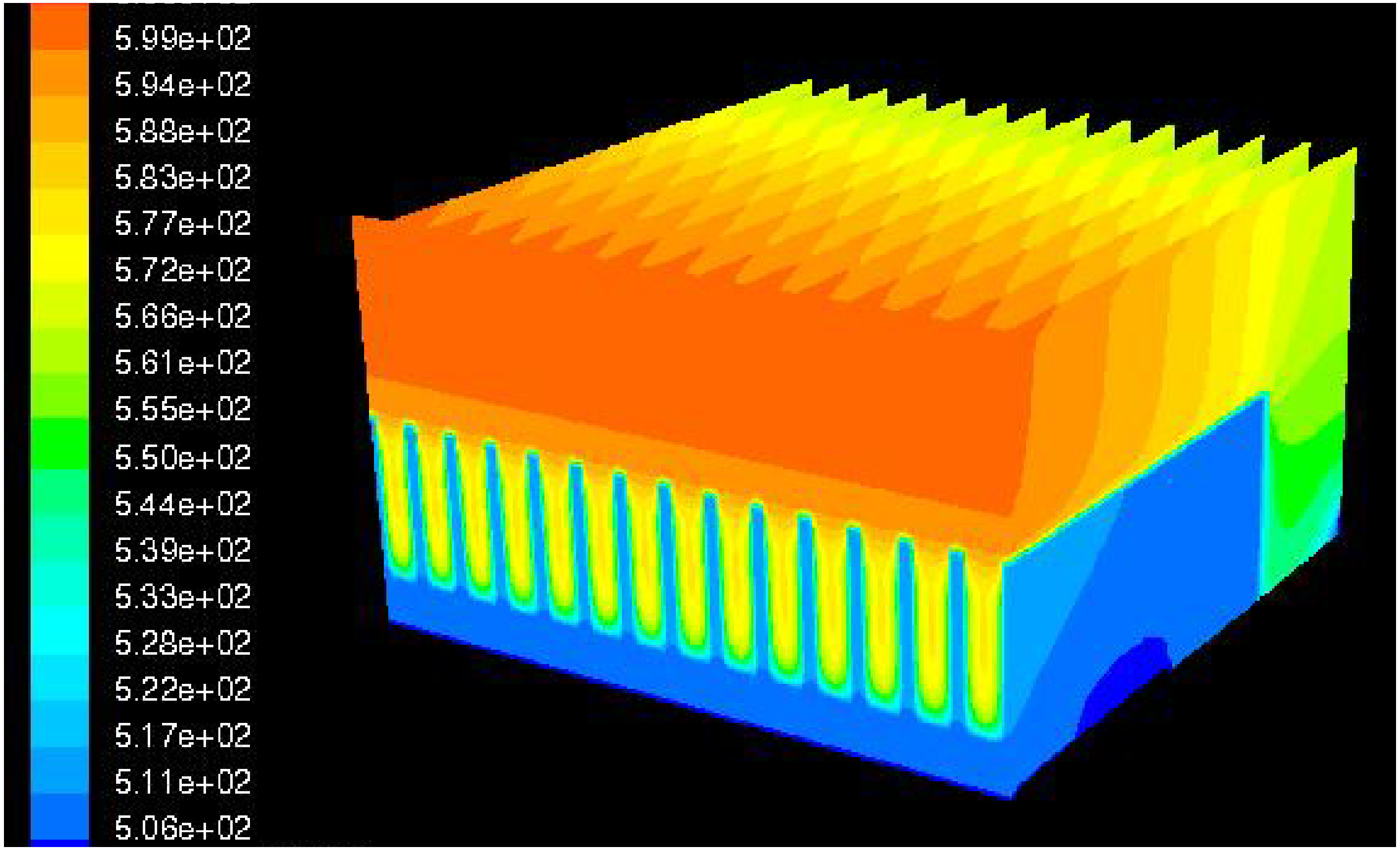
- The cold sink is the second most important component of the system.

- The cold sink must dissipate a large amount of heat coming through the module(~150W), and remain at a low temperature.

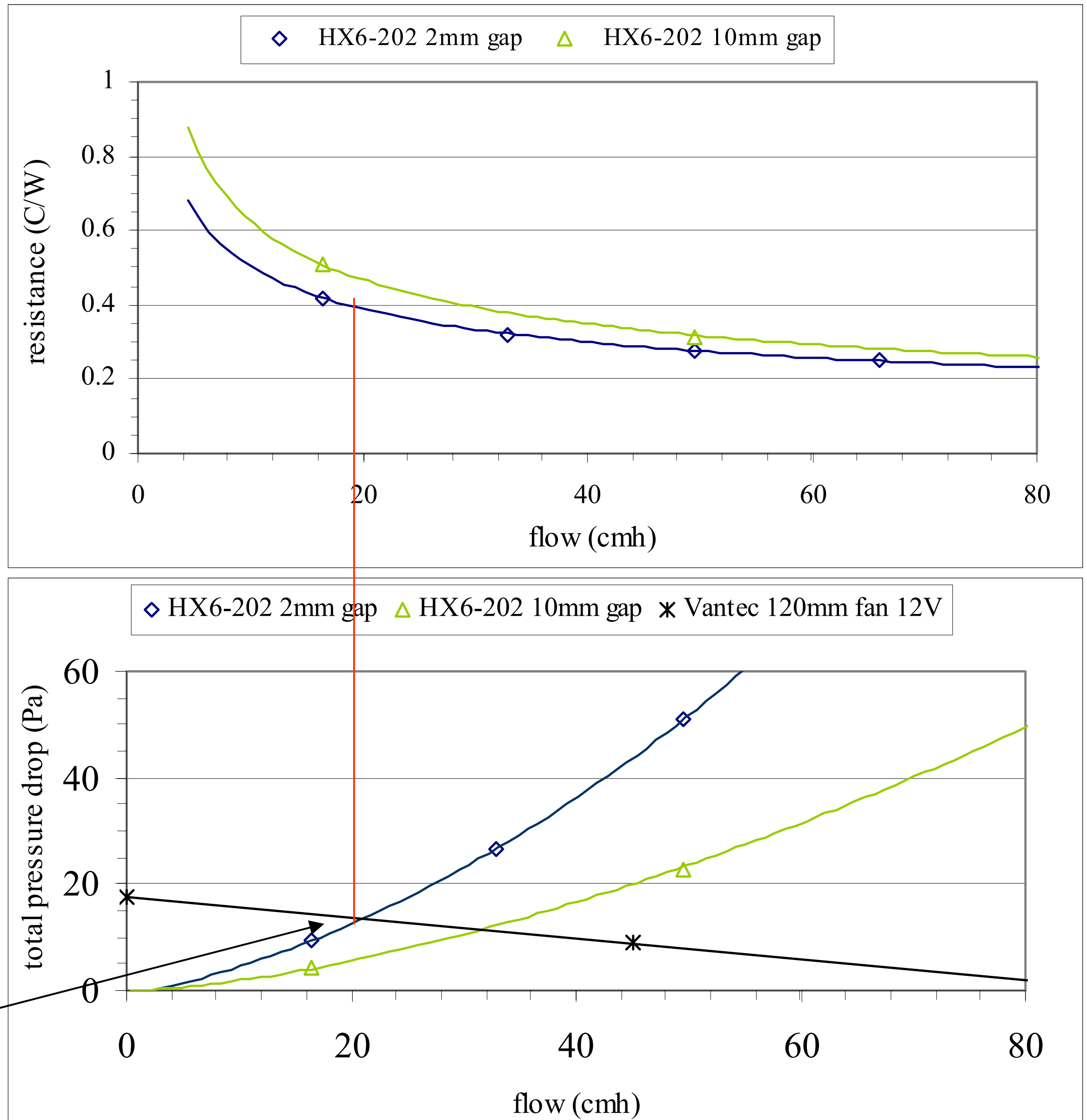
- Fan cooling may be necessary where maximum power or compactness are desired.

Cold Sink Modeling

- A CFD model has been created to predict the performance of the cold sink with fan cooling, and natural convection.



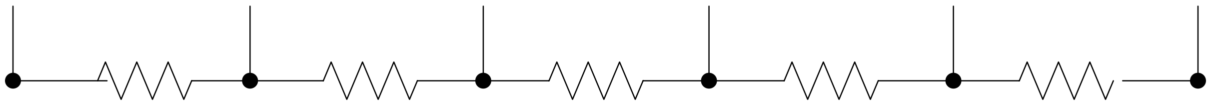
Plots of thermal resistance and pressure drop vs. flow rate



Operating point

Predicting System Performance

- Generators are modeled using a thermal resistance circuit to determine the hot and cold side temperatures of the module



Bench Testing

Results from Bench Testing

- Heat sink resistance = .5 C/W (parallel flow) and .4 C/W (impinging flow)

- Interface resistance = .1 C/W

- Power consumed by fan = 1W

- Net power of module at 250C = 4W

High Intensity LED Lighting

- The 4 W of power generated by the thermoelectric is enough to power a high intensity LED.

Room Lit by Thermoelectric Generator and LED lighting

Future Work

- Future work will focus on using natural convection to replace the fan.
- The natural convection will be aided by draft from the stove