Formative Assessment 1

Thermal Power Engineering MEP112s

Portable Solar Water Dispenser

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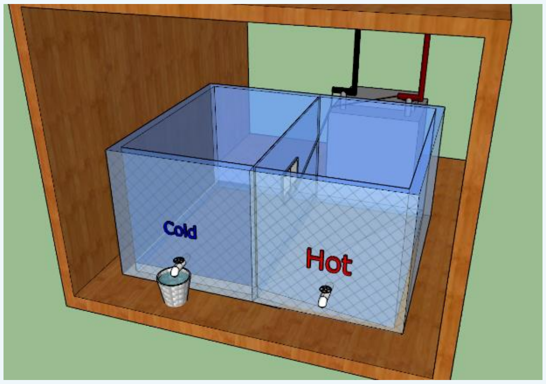
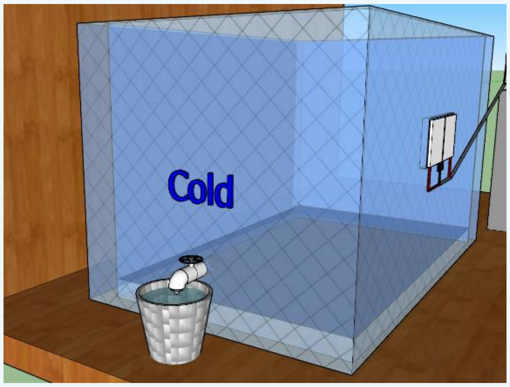
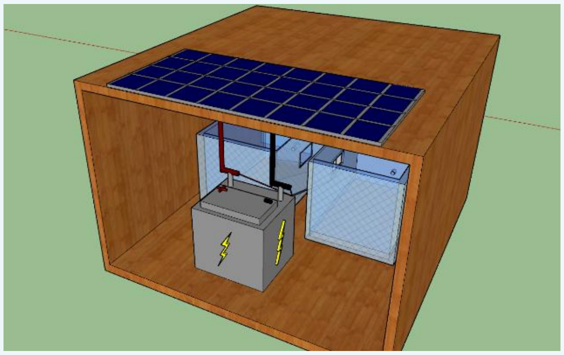
Idea description

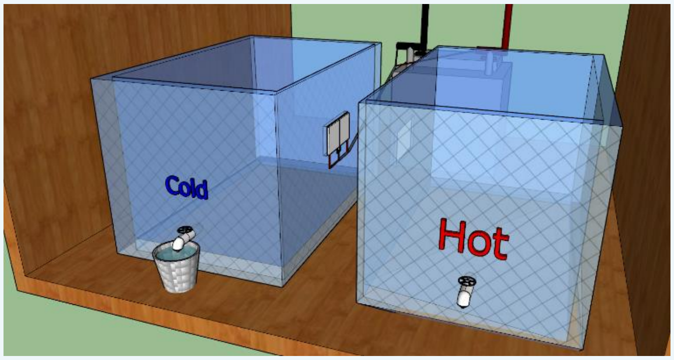
With the expansion of the water dispenser market, product demand is being driven by factors such as portability, ease of use and installation, and low maintenance costs. The main idea of the project is to design a water dispenser that works using the thermoelectric module, which is powered by solar PV cells. The chosen design consists of two containers, two thermoelectric cooler (Peltier) kits, a rechargeable battery, insulating material, taps, and an external wooden frame.





The solar cell is to be put on the top of the wooden frame to capture the light and connected to the battery for the charging process. Each side of the thermoelectric cooler is put on a container, the hot side and the cold side. Then, it is driven by the electrical energy from the battery. The cold side of the Peltier is responsible for cooling the water in the cold container, and heat from the hot side is responsible for heating the water in the hot container. Both the hot and cold containers are to be covered by an insulating material. The maximum reached temperature inside the hot container is 120 °C. The minimum reached temperature inside the cold container is -30°C.



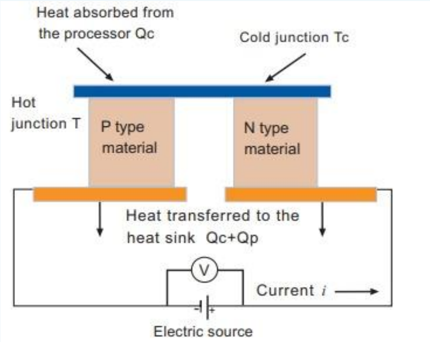


Materials used

Solar Panel (5-watt)	**Rechargeable Battery**	**Peltier (SP1848-27145)**	**Container**	**Taps**	**Insulating material**
					

Scientific basis

Thermoelectric cooling (TEC) changes electricity into refrigeration, when electric current is applied to circuit with distinct conductors one junction is cooled and the other is heated. When an electric current circulates through one or more semiconductors pairs type n and p, it produces a temperature gradient between the junctions. It is used as refrigerator and heat pump at the same time, where we add electrical work (W_{net}) and get (Q_{low}) and (Q_{high}) on both sides of the TEC.



<u>First law of thermodynamics for (TEC) system:</u>

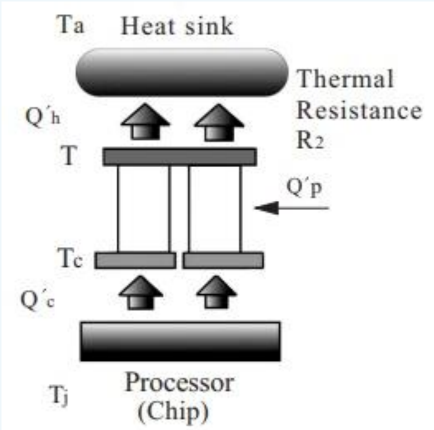
$$Q_c + Q_p - Q_h = \frac{dE}{dt}$$

Where Q_c is the heat transfer rate form the processor, Q_p is the external power used by the TEC, and Q_h is the heat transfer rate dissipated in the heat sink.

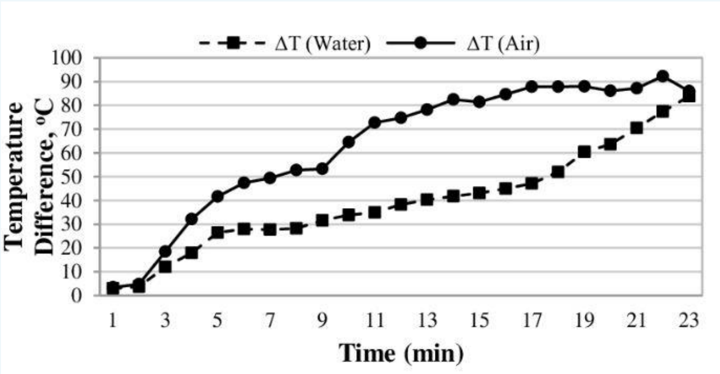
<u>Coefficient of performance of TEC:</u>

$$COP = \frac{\varphi_c}{\varphi_p}$$

where φ_c is heat transfer used to cool the processor and φ_p is power used by TEC.



Schematic diagram of a TEC



Relation between temperature difference and time taken.

Since containers are made of glass or plastic, both materials are not thermal insulators, there would be heat loss caused that should be considered in calculations. This heat loss would be difficult to measure or determine, so it needs to be eliminated. In order to get maximum elimination of the heat loss from the containers, insulation has been used to preserve heat and prevent its transfer to the surroundings as much as possible. Using insulation material such as glass wool or insulation foam (EPS or XPS).

Glass wool

Insulation foam