DESIGN, ANALYSIS AND FABRICATION OF THERMOELECTRIC COOLING AND HEATING SYSTEM FOR WATER DISPENSER

R.S.Fayazahamed[1], S.CyrilJain[2], K.L.Alagarasan[3], A.Balachandran[4], P.Balasubramani[5]

[1,2,3,4] *UG Students, Department of Mechanical Engineering, K.Ramakrishnan College of Engineering, Tiruchirappalli, Tamilnadu, India.*

[5] *Asst Prof, Department of Mechanical Engineering, K.Ramakrishnan College of Engineering, Tiruchirappalli, Tamilnadu, India.*

ABSTRACT

This paper aims toward developing a system which will provide cooling and heating effect simultaneously without moving mechanical parts. Thermoelectric cooling and heating system does not require working fluids. This device can be used to cool water without use of refrigerants. And simultaneously heating can be achieved from the hot side of thermoelectric module to heat the water, this is due to heat absorption and rejection using peltier element. This compact design is very useful in elimination of CFC and it would replace conventional refrigeration system.

Keywords: *Peltier effect, Thermoelectric cooling and heating, forced convection, heat pump, CFC elimination.*

1. INTRODUCTION

We are pleasure to introduce our idea "Thermoelectric cooling and heating System for Water Dispenser" which is equipped by sandwiching the TEC module (Peltier module) between the water blocks. This system uses the principle of peltier effect in which heat is dissipated or absorbed when an electric current flows across a junction between two materials. The TEC has p-type and n- type semiconductors connected in series and covered by silicon bismuth coating. By reversing the polarity the direction of heat pumping is altered. The one side of the module gets colder and another side gets hotter simultaneously. The main objective behind the project is to produce cold and hot water without use of refrigerants and induction coils. It eliminates emission of CFC. It is environment friendly and the thermoelectric modules have a life span more than 2,00,000 hours.

2. OBJECTIVE

1. To eliminate the emission of CFC (Chlorofluorocarbon) from water dispensers, this could ultimately reduce global warming and also reduce power consumption.
2. To provide a system with less maintenance and a long life time.
3. To reduce the size, weight and price of the system.

3. WORKING

Thermoelectric cooling and heating system works on the principle of peltier effect. A DC current is applied with a voltage of 12V to the TEC module. This effect creates a temperature difference on either sides of the TEC module. Heat is removed at one junction and cooling occurs. Heat is dissipated at other junction and heating occurs. The three TEC modules are connected in parallel and sandwiched between the aluminum water block heat exchangers. The aluminum water block is 150mm×70mm×15mm in dimension & has a 8mm grooved path for passing water as shown in fig 3.2. Aluminum water block heat exchanger acts as a heat sink and transmits heat to the water through internal forced convection and deposits on the water container. There are two water reservoirs, cold water and hot water reservoir. The water is continuously pumped from the water reservoirs to the heat exchanger using a water pump. By this process large quantity of water can be cooled and heated. The temperature is distributed uniformly and thermal boundary layer does not affect the performance of the system.

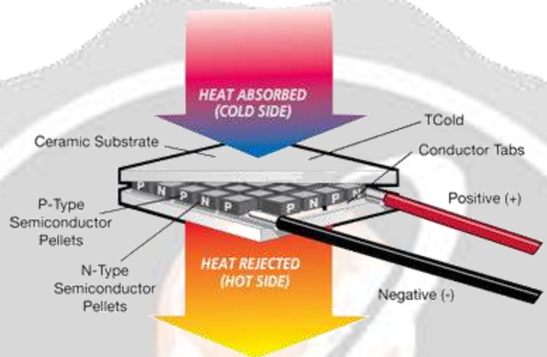
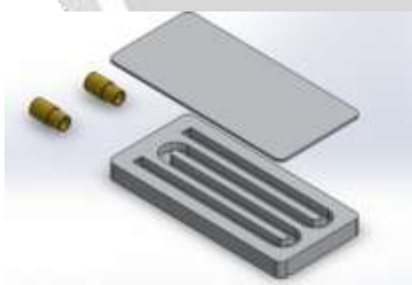


Fig 3.1 Working principle of TEC module



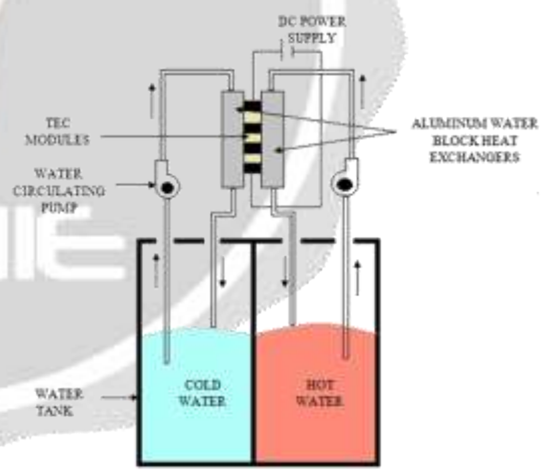


Fig 3.2 Aluminum water block heat exchanger design

Fig 3.3 Schematic diagram of thermoelectric cooling and heating system

4. CFD ANALYSIS

The analysis is performed using solid works flow simulation 2016. The below results are obtained by assuming the ambient temperature of water as 25℃ and room temperature as 27℃. The boundary conditions are set to 0.001kg/s of inlet mass flow and output to environmental pressure condition.

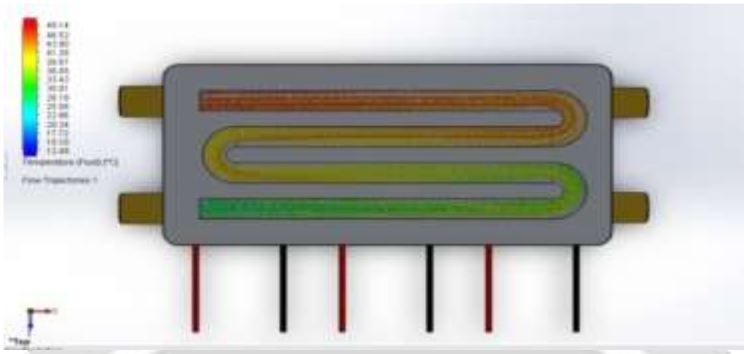


Fig 4.1 Hot side heat exchanger

The figure 4.1 shows the hot side thermal conditions of the water block heat exchanger. The heat rejection rate is 91.8W as calculated. The change in temperature from 25℃ to 47℃ is achieved in the CFD analysis.

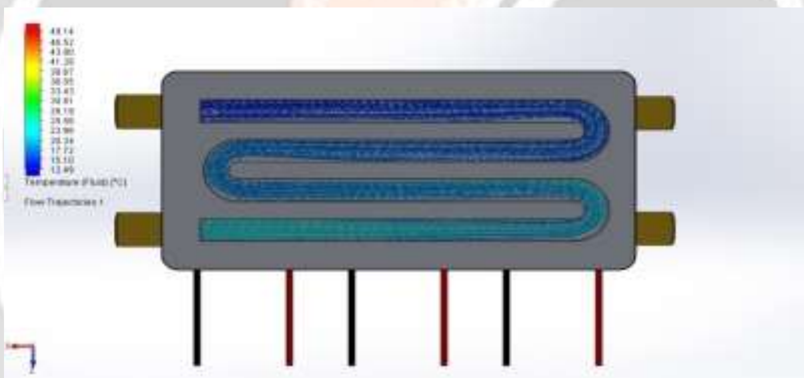


Fig 4.2 Cold side heat exchanger

The figure 4.2 shows the cold side thermal conditions of the water block heat exchanger. The heat absorption rate is -46W as calculated. The negative sign indicated the removal of heat. The change in temperature from 25℃ to 14℃ is achieved in CFD analysis.

5. EXPERIMENTAL ANALYSIS

The model was fabricated and the measurements were taken at the room temperature. The chart below shows the temperature change of water with respect to time. The initial temperature of water was measured to be 27℃ at room temperature. The TEC modules were powered using 12V 240W dc power supply. The sample test of 5L of water on two reservoirs was tested and the change in temperature for every 5 min was measure for a period of 30 min. The change in temperature with respect to the time is plotted in a chart shown below.

The Table 5.1 shows the rise of temperature on the hot side heat exchanger. The temperature of water rises from 27℃ to 45℃. The Table 5.2 shows the fall of temperature on the cold side heat exchanger. The temperature of water falls from 27℃ to 17℃.

Time (min)	T_h (℃)
0	27
5	31
10	34
15	37
20	40
25	42
30	45

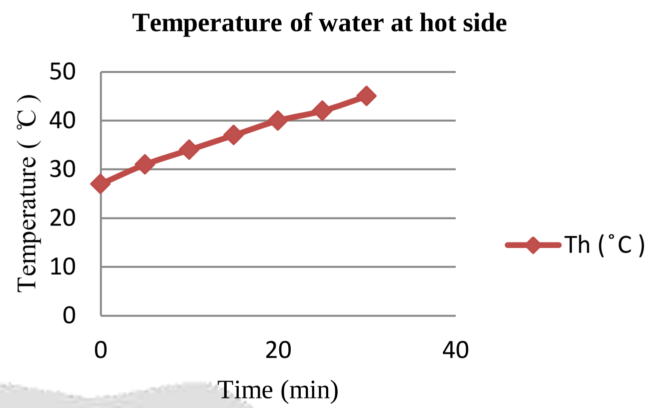


Table 5.1 Temperature vs time on hot side heat exchanger

Time (min)	T_c (℃)
0	27
5	25
10	23
15	21
20	19
25	18
30	17

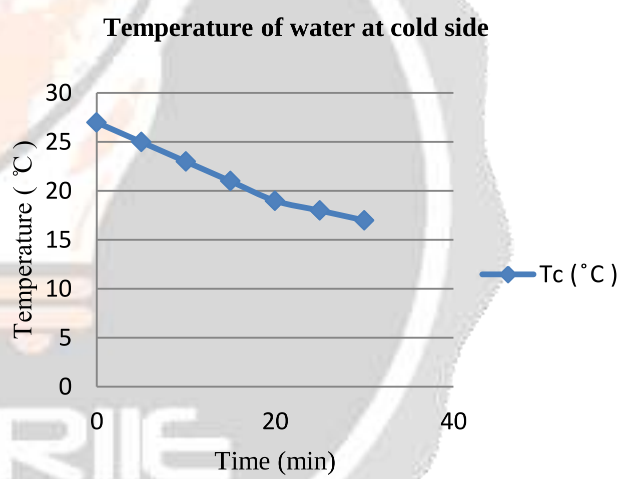


Table 5.2 Temperature vs time on cold side heat exchanger

Fig 5.3 Experimental setup of project

6. CONCLUSION

The Thermoelectric Cooling and Heating system for water dispenser is working with satisfactory conditions. This system produces hot and cold water simultaneously. It is a solid state heat transfer system which requires no use of refrigerants hence there is no emission of CFC. This system is compact and reduces the size, weight and price of water dispenser. This system is less effective for cooling than the conventional water dispenser. But can be improved by using copper heat exchanger. The increase in the power the cooling and heating can be improved and by using a temperature controller the system could be more power efficient. It holds the future of refrigeration for a pollution free environment.

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