International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 08 Issue: 04 | Apr 2021 www.irjet.net p-ISSN: 2395-0072

HOT & COLD WATER DISPENSER WITH PURIFIER

Abhi Jain[1] Jitesh Makwana[2], Parth Mishra[3], Vaibhav Shahanand[4], Dr. Bansi D Raja[5]

[1,2,3,4]UG Students , Dept. of Mechanical Engineering, Indus Institute of Technology and Engineering, Rancharda via. Thaltej, Ahmedabad, Gujarat, India
[5]Dr. Bansi D Raja, Dept. of Mechanical Engineering, Indus Institute of Technology and Engineering, Rancharda via. Thaltej, Ahmedabad, Gujarat, India

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Abstract – *This paper aims toward developing a system which will provide cooling and heating effect simultaneously. 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*

In the present scenario, with theincrease in awareness towards environmental degradation due to the production, use and disposal of Chloro-Fluoro-Carbons(CFCs), Hydro Chloro-Fluoro-Carbons(HCFCs), as refrigerant conventional cooling System. Thermoelectriccooler are compact in size, robust in construction, no coolant require, no mechanical moving components arepresent and total weight of the system is less, noiseless. This paper presents the total Coefficient of Performance (CoP) of a thermoelectric module in combined heating and cooling modes, obtained through experiments and thermodynamics mathematical model.

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

1. INTRODUCTION

We are very pleased to be able to put forward our idea "Thermoelectric heating and cooling system for drinking ", which is equipped with TEC plug-ins (Peltier modules) between the water blocks. The system uses the principle of the Peltier effect, when current flows through the connection between two materials, heat will be removed or absorbed. TEC consists of p-type and n-type semiconductors connected in series and covered with a silicon-bismuth coating. When the polarity changes, the direction of heat transfer also changes. It cools on one side and the other side heats up at the same time. The main goal of the project is to produce hot and cold water without the use of refrigerants and induction coils. Eliminate CFC emissions. It is environmentally friendly, and the service life of the thermoelectric module exceeds 2 million hours.

2. OBJECTIVE

1) To Reduce the global warming effect by eliminating CFC emission through conventional water dispenser 2) Tomake cost effective and lesser size dispenser having low weight3) To make long life dispenser having less maintenance by reducing vibrating elements

3. WORKING

We are very pleased to be able to put forward our idea "Thermoelectric heating and cooling system for drinking ", which is equipped with TEC plug-ins (Peltier modules) between the water blocks. The system uses the principle of the Peltier effect, when current flows through the connection between two materials, heat will be removed or absorbed. TEC consists of p-type and n-type semiconductors connected in series and covered with a silicon-bismuth coating. When the polarity changes, the direction of heat transfer also changes. It cools on one side and the other side heats up at the same time. The main goal of the project is to produce hot and cold water without the use of refrigerants and induction coils. Eliminate CFC emissions. It is environmentally friendly, and the service life of the thermoelectric module exceeds 2 million hours.

4. EXPERIMENTAL ANALYSIS

The model was fabricated and the measurements were taken at the room temperature. The table below shows the temperature change of water with respect to time. The initial temperature of water was measured to be 32°C at room temperature. The TEC modules were powered using 12V 5Amp dc power supply. The sample test of 2.5L of water on two containers 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 graph shown below.

The Table shows the rise of temperature on the hot side & cold side. The temperature of water rises from 32˚C to 50˚C. The Table shows the fall of temperature on the cold side heat exchanger. The temperature of water falls from 32˚C to 21˚C.

Table -1: Hot side readings

Time (min)	T_h(˚C)
0	32
5	35
10	37
15	39
20	42
25	46
30	50

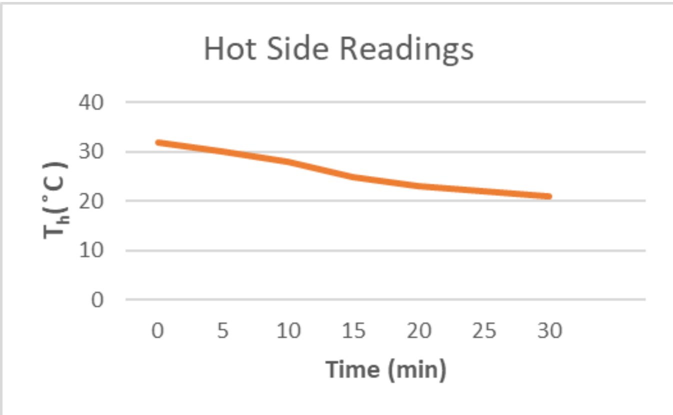

Chart -1: Hot side readings

Table -2 : Cold side readings

Time(min)	T_c(˚C)
0	32
5	30
10	28
15	25
20	23
25	22
30	21

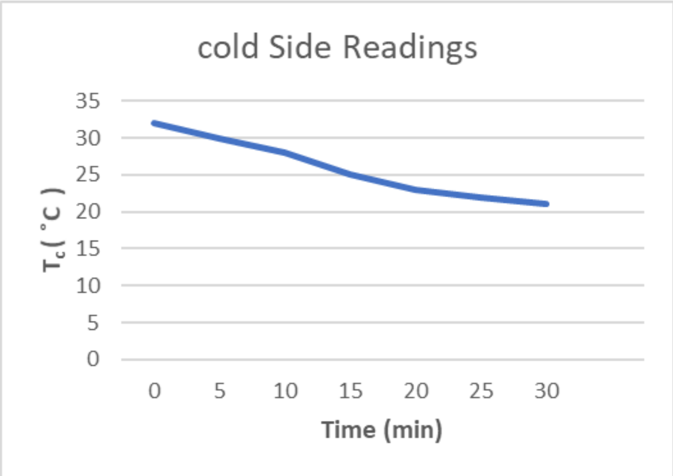

Chart -2: Cold side readings

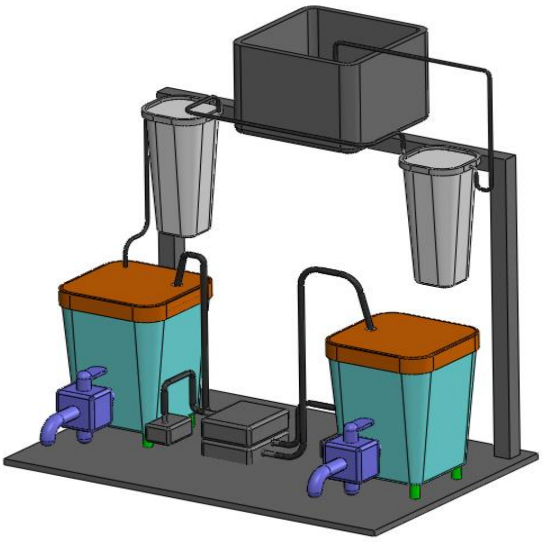

Fig -1 : Solid Work Model of Project

5. Calculation

Thermoelectric module is a solid state heat pump that works based on peltier effect , ohmic heating and conduction between its surface.

The heat pumped on the hot surface Q_h of module & the heat flows through the cold surface Q_c is presented by equation given below

$$Q_h = S_{te} I T_c + \frac{1}{2} I^2 R - \frac{(T_h - Tc)}{R_{te}}$$

$$Qc = S_{te} I T_c - \frac{1}{2} I^2 R - \frac{(T_h - Tc)}{R_{te}}$$

WHERE,

s_{te} = thermoelectric Seebeck coefficient

T_h & T_c= temperature at hot side & cold side of module

I = electric current flowing through module

r = electric electrical resistance

R_{te} = module thermal resistance

$T_h - T_c$ = temperature difference between two surface of module

Thermoelectric thermal resistance (R_{te})

$$R_{te} = \frac{\alpha}{2k_{te}Nc}$$

Where,

α = ratio of elements length to area

k_{te} = material thermal conductivity

N_C = number of the p-n elements

Thermoelectric seebeck coefficient is given by

$$S_{te} = 2S_m N_c$$

Where,

S_m = seebeck coefficient of material

Electrical resistance r is equal to

$$R = 2\rho_m \alpha N_c$$

Where ,

ρ_m = material electrical resistivity

The coefficient of performance of the module in heating & cooling modes is given by below equation

$$CoP_h = \frac{Q_h}{vI}$$

$$CoP_c = \frac{Q_c}{vI}$$

WHERE,

V = SUPPLIED VOLTAGE

I = ELECTRIC CURRENT

TOTAL COEFFICIENT OF PERFOMANCE IS CALCULATED BY THIS FORMULA

$$CoP_t = CoP_h + CoP_C$$

WHERE ,

CoP_t = TOTAL COEFFICIENT OF PERFOMANCE

CoP_h = COEFFICIENT OF PERFOMANCE OF HOT SIDE

CoP_C = COEFFICIENT OF PERFOMANCE OF COLD SIDE

Mathematical calculation as per readings

Temperature at hot side T_h = 50˚ C

Temperature at cold side (Tc) = 21˚ C

So, Temperature difference can be considered as

T= $(T_h - Tc)$ = (50-21) = 29°C

COP can be calculated by dividing the amount of heat absorbed at the cold side to the input power.

COP = QL/Energy supplied (W)

Heat absorption is calculated as bellow.

QL = - [SITc – I^2R – k (T_h – T_c)] = 69.1935

From the first law of thermodynamics, the Energy supplied is:

Energy supplied, W = QH - QL

=SI (T_h – T_c) + I^2 R

=53.9877

The Coefficient of Performance (COP) is obtained by the following empirical equation.

COP = QL/Energy supplied

= [SITc – I^2R – k (T_h – T_c)]

SI (T_h – T_c) + I^2 R

- = $\frac{69.1935}{53.9877}$

COP =1.28

6. Conclusion

The thermoelectric system is pollution free system to produce heating and cooling. It does not require CFC and other elements which generates pollution. Only the limitation of the system is the temperature achieved through thermoelectric system is limited. Especially in cooling side rate of decrease in temperature is lower than heating side but one can improve the rate of cooling by using heat exchanger or temperature controller. The system is compact and reduce in size, weight and price of water dispenser. Ultimately thermoelectric system holds the future of refrigeration for a pollution free environment.

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BIOGRAPHIES

Abhi Jain
Student B.TECH (Mechanical Engineering) Indus University Ahmedabad , India

Jitesh Makwana
Student B.TECH (Mechanical Engineering) Indus University Ahmedabad , India

Parth Mishra
Student B.TECH (Mechanical Engineering) Indus University Ahmedabad , India

Vaibhav Shahanand
Student B.TECH (Mechanical Engineering) Indus University Ahmedabad , India