International Journal of Scientific Research and Engineering Development-– Volume 3 Issue 3, May – June 2020

Available at www.ijsred.com

RESEARCH ARTICLE OPEN ACCESS

Design and Fabrication of Instant Water Cooler Using Thermoelectric Module

Kanchan K. Ingle[1] | Prof. K. N. Wagh[2]

*[1]Department of Mechanical Engineering, Guru Nanak Institute of Technology, Nagpur, Maharashtra, India

(Kanchaningle24@gmail.com)

----------**********----------

Abstract:

The selection of this topic gives us an opportunity to learn new technologies. In the present scenario, with the increase in awareness towards environmental degradation due to the production, use and disposal of Chloro-Fluoro-Carbons(CFCs), Hydro Cholo-Fluoro-Carbon(HCFs), as refrigerant conventional cooling System. Thermoelectric cooler are compact in size, robust in construction, no coolant required, no mechanical moving components are present and total weight of the system is less, noiseless. The research paper is focus on increasing the cooling rate with maintain the less temperature difference between heating and cooling side. The objective of the project is 200ml of water cooling in 30seconds. During the study, focus on design and fabrication of instant water using thermoelectric cooler.

Keywords — Thermoelectric cooler element, heat exchanger, peltier element-TEC1-12706, Thermal paste, heat sink.

----------**********----------

I. INTRODUCTION

A thermoelectric (TE) cooler, sometimes called a **thermoelectric module** or Peltier cooler, could be a semiconductor-based electronic component that functions as a little apparatus. By applying an occasional voltage DC power source to a TE module, heat are going to be moved through the module from one side to the opposite. One module face, therefore, are going to be cooled while the alternative face simultaneously is heated. This method uses the principle of peltier effect during which heat is dissipated or absorbed when an electrical current flows across a junction between two materials. The TEC has p-type and n- type semiconductors connected asynchronous and covered by silicon bismuth coating. By reversing the polarity the direction of warmth 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. A thermoelectric device is one that operates on a circuit that incorporates both thermal and electrical effects to convert heat energy into electrical energy or electrical energy to a temperature gradient. Thermoelectric elements perform the same cooling function as Freon-based vapor compression or absorption refrigerators. **Thermoelectric devices can also be used as refrigerators on the bases of the Peltier effect**. The thermoelectric cooler has great advantages of conventional cooling system. Thermoelectric cooler are compact in size, noiseless, no coolant required, no friction, robust in construction, total weight of the system is less.

Figure.1

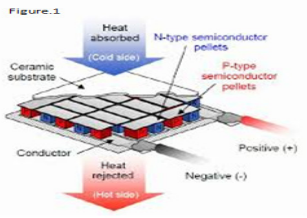
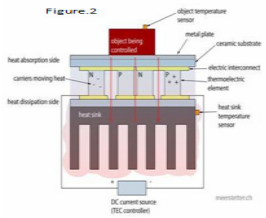


Figure.2



There was improvement in thermoelectric materials from the time of the introduction of semiconductor thermo-elements until the end of the 20th century. However, in recent years, several new ideas for the

improvement of materials have been put forward and significant advances are being made. Presently, in the civil market, thermoelectric refrigeration has a place in medical applications and scientific mechanisms and devices where accurate temperature control is needed. Nevertheless, there are other applications with great potential, in which companies are starting to show interest, e.g., dehumidifiers, domestic and automobile air conditioning systems, portable iceboxes, domestic refrigerators, devices to transport perishable products, computer processor coolers, etc. For these applications, thermoelectric refrigeration competes with conventional refrigeration systems like Vapor compression refrigeration. For a typical conventional refrigeration system, a temperature difference between the ambient and the cabinet of about 25-30 K at Th = 300 K is usually required to achieve satisfactory cooling performance. Thermoelectric modules can be used as thermocouples for temperature measurement or as generators to supply power to spacecraft and electrical equipment. Thermo electronic devices are used in a variety of applications. They are used by the military for night vision equipment, electronic equipment cooling, portable refrigerators and inertial guidance systems.

When the given the power supply to the thermoelectric element one side get and other side get heated if the increased the temperature difference cooling rate is decreases for that heat is removed towards the atmosphere from heating side by using heat sink. Heat sink has a thermal conductor that carries heat away from the CPU or any other heating element into fins that provide a large surface area for the heat dissipate throughout the rest of the computer. Heat sink works through the

process of conductive and convection heat transfer. The heat flow or dissipation through a given heat sink is determined largely by the thermal resistance, thermal conductivity, cooling method and effective surface area.

II. LITERATURE SURVEY

1) **Paper Name: Performance of Thermoelectric Module as a Water Cooler and Water Heater**
Paper Published by: Mohamad Asmidzam Ahamat#1, Razali Abidin*, Siti Muzahidah Abdullah#2
Publishing Year: 2016

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. Thermoelectric module is a solid state heat pump which has a capability to pump heat with the capacity of 100 W or lower. One of the module surface will acts as a heat sink while another surface of the module rejects heat. This provides an opportunity to utilize both surfaces for cooling and heating applications. The objective of this work was to determine the total CoP of the thermoelectric
module when it was operated in a combination of heating and cooling modes.

2) **Paper Name: QUIKCHILL: Thermoelectric water cooler.**
Paper Published by: Franz Louie Chua, Brandon Ohara, Rachel Reid, and Bernadette Tong
Publishing Year: 2013

A thermoelectric water chiller was designed to provide a more energy efficient alternative. Implementing the chiller under the sink provides a convenient means to source cold, filtered water, thereby eliminating the need for water and nice dispensers as well as filtering pitchers. The cooling chamber design integrates thermoelectric modules (TEMs), which operate on the Peltier effect to cool filtered water down to 14□C. The implementation of TEMs reduced current dispenser energy consumption by 82.4%, from 91 W to 16 W.

3) **Paper Name: Comparison of the experimental performance of a thermoelectric refrigerator with a vapour compression refrigerator (VCR).**
Paper Published by: Krishpersad Manohar1 , Ademola Anthony Adeyanju2
Publishing Year:May-June2014

This paper study shows the experimental comparison between a commercial vapor compression refrigerator and a laboratory built thermoelectric beverage cooler. Tests were carried out to determine the time taken for the temperature of 325 ml of water in a glass jar to be reduced from 32oC to below 6oC. The result shows that in the freezer compartment of the commercial refrigerator, the temperature of the water decreased linearly with increasing time. However, for the thermoelectric refrigerator, the water temperature decreased exponentially with increasing time.

4) **Paper Name: Study and Fabrication of Thermoelectric Air Cooling and Heating System**

Paper Published by: Prof. N. B. Totala1, Prof. V. P. Desai2, Rahul K. N. Singh3, Debarshi Gangopadhyay4, Mohd. Salman Mohd. Yaqub5, Nikhil Sharad Jane6

Publishing Year: August 2014

In this paper observed, during the last two decades that the O3 layer is slowly destroyed because of the refrigerant (CFC and HFC) used for the refrigeration and air- conditioning purposes. The common refrigerant used is HFC's which are leaked and slowly ascend into the atmosphere. When they reach to O3 layer they act on O3 molecules and the layer of O3 is destroyed. A single molecule of HFC can destroy thousands of O3 molecules and that's why it has created a threat for the not only to maintain earth eco system stable but also to existence of earth. Even the percentage of HFCs are emitted into the atmosphere compared to CO2 is negligible but its global warming effect is few thousand times of CO2. The effect of 100 gm of HFC can destroy 0.5 tons of O3 molecules. These HFCs once destroy O3 layer; it takes hundreds of years to recover its thickness as it is formed by complex reactions. This is because as HFCs comes in environment, they remain in atmosphere for 18 years. The capacity of HFCs to increase in earth temperature 10% is contributed by HFC's only. That leads to the emergence of finding an alternative of the conventional HVAC system, i.e. thermo-electric cooling and heating system.

III. PROBLEM DEFINITION

According to season human needed cold water and hot water. In households refrigerator used for cooling water. And the water takes more than 5 to 6 min for cooling. Space also required more, weight of refrigerator is in between 90 and 181 kg. And the cost of refrigerator is high.

The water dispenser seen in Industry, malls, offices, hospitals, etc… Those water cooler used storage system, And the cooling capacity is more. In household those water cooler not used because it is very costly, and more space required. Hence the thermoelectric element is easily available in market and light weight. By using this element water is cool. And used these water in for household. for It has become commonplace for households to purchase these water dispensers so that you need not have to worry about refilling the water bottles in the fridge. You can as well have your glass of refreshing cold water directly from the tap. Hence, The instant water cooler is required less space, compact in size, less time require for cooling water, more efficient.

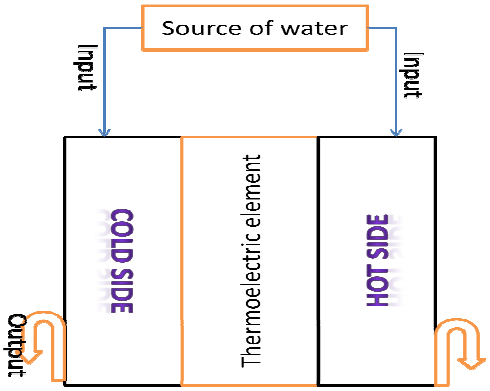
IV. OBJECTIVES

The objective of my project are :

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) Minimization of cost of the system.
4) To reduce the size and weight of the system.
5) Increasing the cooling rate with maintaining temperature difference.
6) 200ml of water cool in 30seconds.

V. PROPOSED PLAN OF WORK

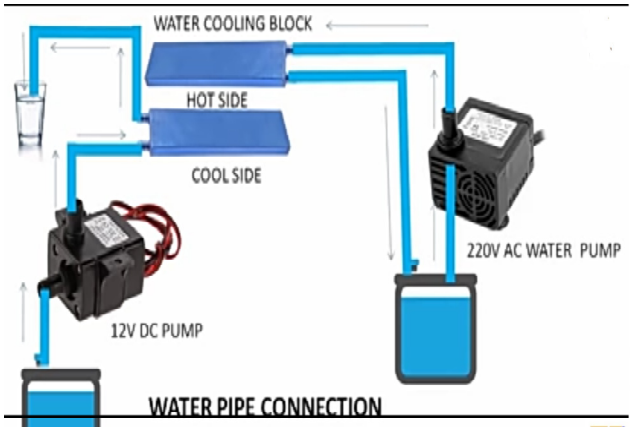
Figure of instant water cooler



VI. WORKING OF INSTANT WATER COOLER

The thermoelectric cooler element or peltier element TEC1-12706 and apply both side thermal paste properly. One heat exchanger mount on cold side and another side (heating side) also mount heat exchanger. After that insulated the assembly part using thermal insulated tape because heat is not transfer from one side to another. Insulation used for cold side because heat is not dissipated to atmosphere. Material of insulation is used thermocoal. Connect the pipe hot and cold side, one side

get input and another side get output. Connect the power supply.



When power supply is on thermoelectric cooling element one side heated and another side is cooled. By using conduction the heat transfer in the heat exchanger water is flowing inside of pipe the baffle plate is working as obstacle and helps for increasing cooling rate. And get the output of cooling and heating water simultaneously.

VII. ADVANTAGES

- Total weight of the system is less.
- Less space required.
- Cost of the system is less.
- Noiseless.
- More efficient.
- Easy to manufacture.

VIII. DISADVANTAGES

- When open the valve for cold side, get both water simultaneously if you not required.

IX. SCOPE

- The thermoelectric cooler element used for generating electricity like in thermal power plant.
- The thermoelectric element used in cooling : 1) Medical field, Industrial area, etc..

X. CONCLUSION

- The thermoelectric cooling and heating system for water cooler and heater (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 When open the valve for cold side, get both water simultaneously if you not required.

Hence there is no emission of CFC. In the paper arrangement is effective and maintain the temperature difference with these minimize the cost. And our objective satisfied.

REFERENCES

1) Kaseb S., El-hairy G, Electronics Cooling, Mechanical Power Engineering Department, Faculty of Engineering, Cairo University, Egypt .
2) H. Sofrata, "Heat rejection alternatives for thermoelectric refrigerators," Energy Conversion and Management, vol. 37, pp. 269-280, 1996
3) Enescu D, Virjoghe EO, A review on thermoelectric cooling parameters and performance, Renewable and Sustainable Energy Reviews , 2014, 38:903–916.
4) Goldsmith, H.J. , Introduction to thermoelectricity, Springer-Verlag Berlin Heidelberg 2010.
5) D. Zhao, G. Tan, A review of thermoelectric cooling: materials, modeling and applications, Applied Thermal Engineering (2014), doi: 10.1016/ j.applthermaleng.2014.01.074.
6) S. Riffat, X. ma, Improving the coefficient of performance of thermoelectric cooling systems, international journal of energy research Int. J. Energy Res. 2004; 28:753–768.
7) J. Vian, D. Astrain, “Development of a heat exchanger for the cold side of a thermoelectric module”, Applied Thermal Engineering 28 (2008) 1514–1521.

8) https://www.electronicscooling.com/2003/05/anintroduction-to-pulsating-heat-pipes/
9) "Intermediate Temperature Heat Pipe Life Tests and Analyses". www.1act.com.
10) "Heat Pipes", Fifth Edition, D. A. Reay, P.A. Kew.
11) M A Ahamat & M. J. Tierney, Timewise temperature control with heat metering using a thermoelectric module, Applied Thermal Engineering 31 (2011) 1421-1426
12) M A Ahamat & M. J. Tierney, Calorimetric assessment of adsorbents bonded to metal surfaces: Application to Type A silica gel bonded to aluminium, Applied Thermal Engineering 40 (2012), 258-266
13) Mohamad A. Ahamat & Michael J. Tierney. Calorimetric Assessment of Rates of Desorption, Heat Transfer Engineering, Volume 37, Issue 7-8, 2016
14) Nizar Ahammed, Lazarus Godson Asirvatham, Somchai Wongwises. Thermoelectric cooling of electronic devices with nanofluid in a multiport minichannel heat exchanger, Experimental Thermal and Fluid Science, Volume 74, June 2016, Pages 81-90
15) Chein R, Huang G. Thermoelectric cooler application in electronic cooling. Applied Thermal Engineering 2004;24 :2207–17.
16) Putra N, Yanuar, Iskandar FN. Application of nanofluids to a heat pipe liquid- block and the thermoelectric cooling of electronic equipment. Exp Therm Fluid Sci 2011; 35:1274–81.
17) Performance of Thermoelectric Module as a Water Cooler and Water Heater Mohamad Asmidzam Ahamat#1, Razali Abidin*, Siti Muzahidah Abdullah#2 # HVACR Section, Universiti Kuala Lumpur, Malaysia France Institute, Bandar Baru Bangi,Selangor, Malaysia. E-mail: 1asmidzam@unikl.edu.my, 2muzahidah@unikl.edu.my
18) Design and Fabrication of a Peltier Operated Portable Air Cooling System
19) Nilesh Varkute, Akshay Chalke, Deepak Ailani, Ritesh Gogade, Ajay Babaria Mechanical Engineering Department, F.C.R.I.T Vashi, Navi Mumbai, Maharashtra, India

