ISSN 2395-1621

Design, Fabrication and Testing of Peltier plate refrigeration effect by forced convection

[#1]Mr.S.J.Zagade, [#2]Mr.B.B.Patil, [#3]Mr.O.S.Mane, [#4]Mr.A.A.Nikam, [#5]Mr.A.A.Kore, [#6]Prof.Suraj Patil

[#12345]Research Student, Department of Mechanical Engineering, A.G.C.E.Satara.
[#6]Prof. Department of Mechanical Engineering, A.G.C.E.Satara.

ABSTRACT

Now a days, in conventional refrigeration system, the discharge of chlorofluorocarbon(CFC) and hydro fluorocarbon(HFC) has become a huge problem towards environment pollution, so to decrease the pollution which is caused by conventional refrigeration system the thermoelectric effect is used. This concept of thermocouple which is obtained by maintaining potential difference between the two junctions at different temperatures and vice versa. This is because heat directly converts temperature difference into voltage gradient without any usage of mechanical system. In this project, the refrigeration is done by using peltier plate which is not harmful to the environment.

ARTICLE INFO

Article History

Received: 25th March 2017

Received in revised form :

25th March 2017

Accepted: 25th March 2017

Published online :

4th May 2017

Keywords: Peltier Effect, Heat sink, Fans, Thermoelectric module.

I. INTRODUCTION

The conversion of electrical energy into thermal energy by using solid state device is done by thermoelectric coolers and then build up the temperature gradient, which call the Peltier Effect[1]. The Thermoelectric coolers have a wide applications which are used to cool the electronic compounds such as infrared detectors and have the ability to control accurate temperature for precise devices such as solid-state lasers.

They can also be applied in a portable refrigerator for small item storage for medical or domestic purposes.Working fluids used in the conventional air conditioning system such as chlorofluorocarbons and it stransient hydrochlorofluorocarbons are harmful to the environment and need careful consideration to safety because they are highly flammable or toxic. For certain applications, TEC systems may have more potential to replace traditional air conditioning systems because of their lack of working fluids. TEC systems making them complete environmentally friendly units.

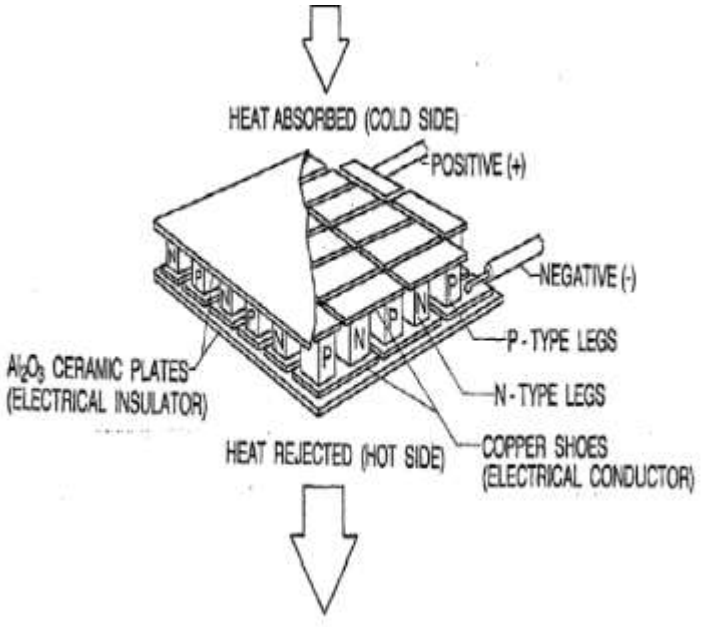


Fig 1 Model of peltier plate.

© 2017, IERJ All Rights Reserved

II. PROBLEM STATEMENT

The conventional air conditioning system produces harmful effects on environment because of presently used refrigerants which are highly toxic if they are leaked to atmosphere. They pollute the earth's crust and so become hazardous to living organisms.

Design assembly:

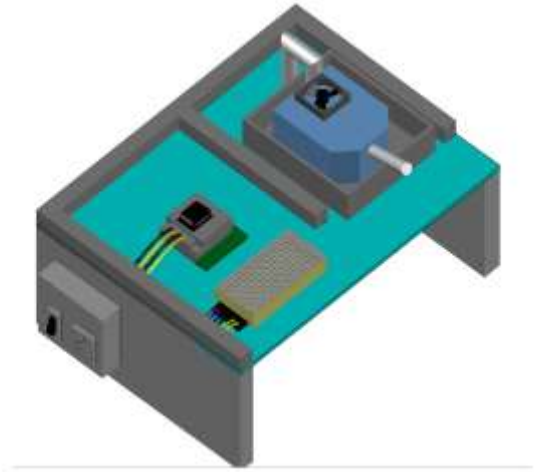


Fig 2. Assembly of the refrigeration system.

Design calculation:

Calculation of performance for forced convection.

Cross sectional area(A_c):

A_c =w*t

Perimeter:

=2(w+t) or 2*w (if t<<<w)

Length, L

For calculating heat transfer rate finite short fin given by

$$Q=\sqrt{h*p*k*A}*\theta_0\left[\frac{\tanh(mL)+\frac{h}{mk}}{1+\frac{h}{mk}*\tanh(mL)}\right]$$

$$m=\sqrt{\frac{hp}{kA}}$$

θ_0=T-Ti

Calculations for heat transfer rate, Q:

Area(A):

A=w*t

=0.151*0.003

=4.53*10^{-4} m^2

Perimeter(P):

P=2w

……(t<<<w)

=2*0.151

P = 0.302 m

Thermal conductivity(K):

=202 W/mK ……. (for aluminum)

Convective heat transfer coefficient(h):

h=9 W/m^2K

$$m=\sqrt{\frac{9*0.302}{202*4.53*10^{-4}}}$$

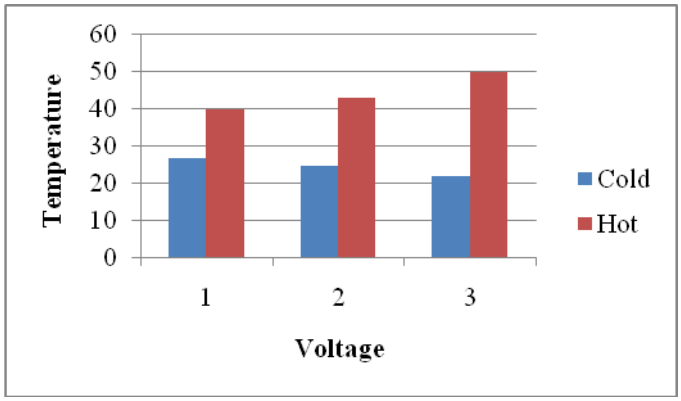
=5.45

By applying various voltages calculate heat transfer rate.

III. RESULT TABLE

1. For air convection:

Voltage (v)	Inlet Temp of air	Cold side temp of (TEP)	Hot Side Temp of (TEP)	Outlet Temp of air	Cooling effect Δtc (Ti-Tc)	Heating Effect Δth (Th-Ti)	Heat rejection	Heat generation
4	34	27.1	40	29	6.9	6	0.43	0.49
6	32.8	25	43	27.1	7.8	10.2	0.73	0.56
8	33	21.8	50	27.20	11.2	12.3	1.21	0.87

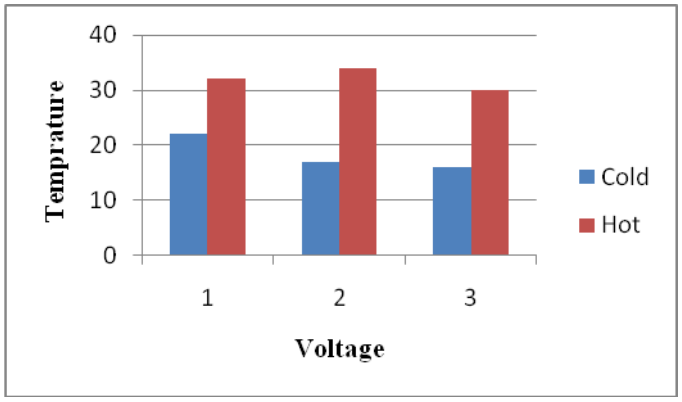


Graph1. For temp rate VS voltage (Air cool).

© 2017, IERJ All Rights Reserved

2. For water convection:

Voltage (v)	Inlet Temp of air	Cold side temp of (TEP)	Hot Side Temp of (TEP)	Outlet Temp of air	Cooling effect Δtc (Ti-Tc)	Heating Effect Δth (Th - Ti)	Heat Rejection	Heat Generation
4	30	21	31	26.1	9	1	3.05	0.33
6	30	16.5	34.2	27.1	13.5	4.2	4.57	4.89
8	30	16.1	34.2	20.3	13.9	4.2	4.72	0.21



Graph 2 for temp VS voltage (Water cool).

IV. CONCLUSION

There are several different types of cooling devices available to remove the heat from industrial enclosures, but as the technology advances, thermoelectric cooling is emerging as a truly viable method that can be advantageous in the handling of certain small-to-medium applications. It is compact in size, harmful coolant is not required and weight of the system is low. This works on peltier effect. Compatibility of thermoelectric cooling systems have made them more useful and appropriate for environment protection.

REFERENCES

1. Ajitkumar N. Nikam1, Dr. Jitendra A. Hole2,“ A Review on use of Peltier Effects”, Pratibha: International Journal Of Science, Spirituality, Business And Technology (Ijssbt), Vol. 2, No. 2, May 2014

2. Limei Shena, Fu Xiao, Huanxin Chen, Shengwei Wangb, “Investigation of a novel thermoelectric radiant air-conditioning system”, Contents lists available at SciVerse Science direct, Energy and Buildings 59 (2013) 123–132.2.

3. Rohit Sharma, Vivek Kumar Sehgal, Nitin, Abhinav Thakur, Adnan Munir Khan, Ashish Sharma, and Pankaj Sharma, “Peltier Effect Based Solar Powered Air Conditioning System”, International Conference on Computational Intelligence, Modelling and Simulation, 2009

4. Mark Gillott, Liben Jiang, and Saffa Riffat, “An investigation of thermoelectric cooling devices for small-scale space conditioning applications in buildings”, international journal of research Int. J. Energy Res. 2010; 34:776–786 Published online 15 July 2009.

5. Bao Yang, PhD Herwin Ahuja Thanh N. Tran, PhD, “Thermoelectric Technology Assessment Application to Air Conditioning and Refrigeration”, May 12. 2008

6. D.D.L. Wijngaards, E. Cretu, S.H. Kong and R.F. Wolffenbuttel, “Modelling of integrated Peltier elements” Electronic Instrumentation Laboratory, Delft University of Technology / DIMES

© 2017, IERJ All Rights Reserved