EFFECT OF PHASE CHANGE MATERIAL OF PERFORMANCE OF A REFRIGIRATOR

RAJESH.M[1], RAVI KUMAR.P[2], VIJAYAN.M[3]

[1] U G Student Department of Mechanical Engineering, PSVPEC, Chennai, India
[2] U G Student Department of Mechanical Engineering, PSVPEC, Chennai, India
[3] Assistant Professor Department of Mechanical Engineering, PSVPEC, Chennai, India

Abstract - The experimental investigation of the performance improvement of refrigeration using distilled water and wax phase change material has been carried out. The PCM is the Latent heat thermal energy storage system which could be a new concept of performance improvement of a household refrigerator buy enhancing heat transfer in the evaporator. The PCM is located in over the evaporator cabinet in domestic refrigeration system has been tested with two different phase change material as distilled water and paraffin wax solution at different thermal load. experimental results show that the system withstand more cooling of refrigerator cycle with PCM is considerable longer than that of without PCM with increase at the quantity of PCM, COP increases.Depending on the thermal load and the type of PCM, average thermal load on the type of PCM average compressor running time for cycle is reduced significantly.

Keywords –REFRIGERATION SETUP ,PCM

I. INTRODUCTION

Domestic refrigerators and freezers are among the most energy demanding appliances in a household due to their continuous operation. Worldwide the no. of consumers is constantly increasing. The study shows that refrigerator consumes about 1/4th of the total energy consumption in a house. It also accounts to about 1/6th of greenhouse gas emission. Although, the recent technologies use hydrocarbon as a refrigerant to reduce the greenhouse gas emission; the overall performance enhancement of domestic refrigerator is mandatory to reduce the indirect emissions and the amount of energy consumption.

II. RELATED WORK

C. Marques, et al.(2013) investigated the performance improvement provided by a phase change material associated with the evaporator in a domestic refrigerator. The heat release and storage rate of encapsulated ice, used as the thermal energy storage material, has been investigated numerically. The mathematical model for phase change is based on the enthalpy method and the governing equations were discretized on a fixed grid using the finite difference method.

Abhilash A, et al. (2015) investigated the temperature fluctuation inside the evaporator cabin a household refrigerator using phase change materials at same thermal loads. Use of PCM in a household refrigerator decreases the fluctuation of the cabinet temperature. The reduction of

temperature fluctuation between two PCM, however depends on the latent heat capacity and the properties such as melting point of PCM. At higher load more amount of PCM is required for significant change. Fluctuation of temperature due to frequent powercuts can be thus reduced and this leads to less thermal distortion in the food materials and good quality of food preserved. The refrigerator Efficiency was strongly affected by the refrigerator heat load and compressor cooling capacity which draws less power.

Adnan hassan, et al. (2013) investigated the performance improvement of a household refrigerator using two different phase change materials of different quantities at different loads. Depending on the PCM and the thermal load around 18-26% COP improvement has been achieved by the PCM in respect to without PCM. Use of water as PCM imposes a great impact on COP improvement at certain thermal loads. Using water as PCM and certain thermal load it is found that the 18-26% COP improvement has been achieved by the PCM in respect without PCM in conventional refrigerator.

III. OBJECTIVES

1. To modify the evaporator for provided PCM to improve the performance
2. To withstand cooling effect for long time and also reduce the cooling loss
3. The distilled water and wax PCM for improvement of COP around the evaporator
4. Experimentally calculate the COP, Cooling load and enthalpy
5. To compare the result and performance of refrigerator using PCM with domestic refrigirator

IV. WORKING PRINCIPLE

1. The compressor constricts the refrigerant vapor, raising its pressure and temperature, and pushes it into the coils of the condenser on the outside of the refrigerator.
2. When the hot gas in the coils of the condenser meets the cooler air temperature of the kitchen, it becomes a liquid.
3. Now in liquid form at high pressure, the refrigerant cools down as it flows through the expansion valve into the evaporator coils inside the freezer and the fridge.
4. The refrigerant absorbs the heat inside the fridge when it flows through the evaporator coils, cooling down the air inside the fridge.
5. Last, the refrigerant evaporates to a gas due to raised temperature, and then flows back to the compressor, where the cycle starts all over again.

TEST PROCEDURE

Note down the pressure readings at compressor suction and discharge using pressure gauge
Make note of temperature at various points using thermocouple such as
Compressor inlet
Compressor outlet / condenser inlet
Evaporator inlet
Evaporator outlet
Cabinet inside temperature (On time & off time)
Switch off the setup
Make note of temperature inside cabinet decreasing with respect to time
Plot the graph between evaporator temperature and time
Repeat the same procedure for placing PCM
Analyse the graph and results and finally conclude

V. DIAGRAM

Figure 1. 3D Diagram

VI. DESIGN CALCULATION

Dimension : 40 x 30 x 13 cms

Thickness : 3mm

Material : Polystyrene

Q= UA(T1-T2)

R_{tot} = (1/c) + (t/k)

C= Conductance = 0.18

K= Conductivity = 0.16

Dimension : 40 x 30 x 13 cms

Thickness : 3mm

Material : Polystyrene

Q= UA(T1-T2)

R_{tot} = (1/c) + (t/k)

C= Conductance = 0.18

K= Conductivity = 0.16

Q= 0.0187 x 6.286 x 5

= 0.5877 BTU/hr

= 0.62 KJ/hr

VII. AFTER MODIFICATIONS

Fig 2 After Modification Engine

VIII. CONCLUSION

Experimental tests have been carried out to investigate the temperature fluctuation inside the evaporator cabin a household refrigerator using phase change materials at same thermal loads. Use of PCM in a household refrigerator decreases the fluctuation of the cabinet temperature. The reduction of temperature fluctuation between two PCM, however depends on the latent heat capacity and the properties such as melting point of PCM. At higher load more amount of PCM is required for significant change.

REFERENCES

[1]. R. Elarem et al., 2017. Performance analysis of a household refrigerator integrating a PCM heat exchanger. Applied Thermal Engineering.

[2]. IBEF presentation, Indian Consumer Durables Industry Analysis, https://www.ibef.org/industry/consumer-durables-presentation (accessed 27 September 2017, 9 November 2017).

[3]. W. Cheng et al., 2011. A novel household refrigerator with shape-stabilized PCM (Phase Change Material) heat storage condensers: An experimental investigation.

[4]. K. Azzouz, D. Leducq, D. Gobin, 2008. Performance enhancement of a household refrigerator by addition of latent heat storage