Thermosyphon Assisted Defrosting System In Domestic Refrigerator

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Abstract- *The main problem associated with domestic refrigerator is high defrosting time and non uniform cooling in the cabinet i.e. the upper portion of refrigerator is at very low temperature than the bottom portion of refrigerator shelf and also during defrosting time cooling of food products is not carried out.This problem can be eliminated by using thermosyphon, which provides uniform cooling throughout cabinet by using volatile fluid. Here the fluid in thermosyphon absorbs heat from bottom shelf of the refrigerator and rejects the heat at evaporator. So that uniform temperature is maintained in the refrigerator cabinet, which intern reduces the spoilage of food and also reduces the frosting on evaporator coil.*

Keywords- thermosyphon, methanol.

I. INTRODUCTION

In today's refrigeration systems there is a problem of non uniform cooling among the shelves of the refrigerator. There is another problem of large defrosting time and no cooling effect during defrosting process. This problems can be eliminated by using thermosyphon assisted domestic refrigerator. Thermosyphon is a passive element maintains uniform temperature throughout refrigerated space and minimizes frosting on the evaporator coil. In the present work two types of thermosyphons are used, one is single phase thermosyphon and another one is two phase thermosyphon. In case of single phase thermosyphon the heat transfer is carried by convection only where as two phase thermosyphon transfers heat by convection and phase change. In single phase thermosyphon working medium is non volatile in nature, where as in two phase thermosyphon the working medium is volatile in nature. In the present work the volatile fluid used in thermosyphon is methanol and non volatile fluid is water.

II. LITERATURE REVIEW

McDonald et al. (1) the initial experimental study was limited to the performance of single loops. Results were obtained using two different working fluids, R-113 and R-11. The performance curves were presented in terms of loop conductance defined as the inverse of the effective thermal resistance offered by the thermosyphon loop between the heat source and the heat sink. The amount of refrigerant in the system, the angle of inclination of the evaporator and condenser tubes, and the source and sink temperatures were systematically varied. Evaporator dry out and condenser flooding were the two determining factors in arriving at optimum system performance.

Ali and McDonald et al. (2) simulated the performance of thermo siphon loops by utilizing the available empirical correlations for evaporation and condensation heat transfer coefficients, and single-phase and two- phase pressure drops. Based on the above simulation, McDonald and Ali generated performance characteristics of the 3 thermosyphon loops which compared reasonably well with the experimental results.

McDonald and Sampathet al.(3)Further experimental studies on unidirectional and bidirectional thermosyphon loops were conducted. In general, thesestudies indicate that the amount of refrigerant, or charge, is a very important factor in thesystem performance.

Seki etal.(4) studied the concentric tube thermosyphon, and proposed correlations for boiling heattransfer coefficient in annular spaces for design purposes. Concentric tube thermosyphon offers a simplified system by using the annular region to boil off the refrigerant, which rises to a condensing space above. Condensed liquid is returned to the bottom of the annular region through the inner tube.

III. EXPERIMENTAL SETUP & METHADOLOGY

The layout of the thermosyphon assisted domestic refrigeration cycle as shown in figure1. The main components are R600a compressor, thermosyphon, condenser, capillary tube, expansion valve. The thermosyphon has actually made with coppersheet as shown in figure 3. The main objective of thermosyphon is to maintain uniform temperature throughout refrigerated space. In the proposed layout of the tested refrigeration system, the thermosyphon is placed on the top of the evaporator as shown in the fig. Secondary function of the thermosyphon is eliminates frosting on evaporator.

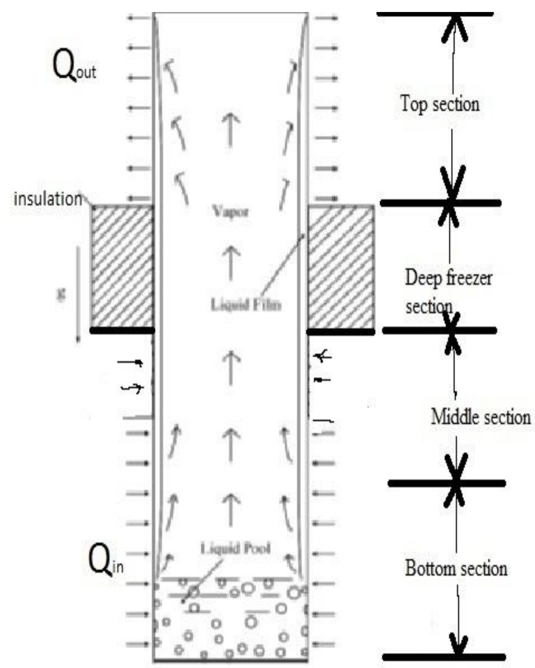

Fig 1: Schematic diagram of thermosyphon

A) Thermosyphon working

A two-phase closed thermosyphon is a type of heat pipe without an internal wick, as shown in Fig. 2 It is simple in construction and design, consisting of a hollow tube that is oriented vertically and has been evacuated and filled with a working fluid. Heat is added at the bottom shelf of refrigerator, vapourizing the working fluid and causing it to rise to the top of the device to the evaporator. Heat is removed in the evaporator, causing the vapour to condense onto the pipe wall. The liquid flows back down the sides to the bottom shelf of refrigerator by gravity and the process repeats.An optional, insulated middle section, called the adiabatic section, may be present as well. The heat transfer mechanisms in the bottom shelf of refrigerator are more complicated than those in the evaporator because the falling liquid film and the liquid pool in the bottom of the device participate in the phase change and heat transfer simultaneously. Different heat transfer regimes are possible, depending on the intensity of the wall heat flux in both liquid film and liquid pool. Several factors limit to the maximum heat transfer that can pass through the thermosyphon. Dry-out occurs when there is not enough working fluid present, and dry regions form on the evaporator walls. Conversely, if too much liquid is present, pool flooding occurs, in which the liquid pool fills and then expands beyond the bottom section due to nucleate boiling. The counter-current flooding limit occurs at high vapour velocities where the upward-moving vapour exerts significant shear stress on the falling liquid film, causing the film thickness to increase or separate from the wall completely.

IV. EXPERIMENTAL RESULTS

A) Comparison of refrigerator shelves temperatures

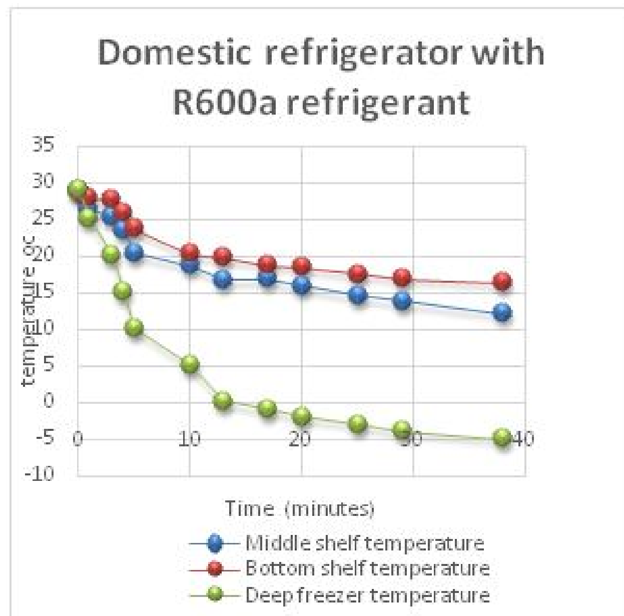

Fig. 3 Time vs Shelves temperature of domestic refrigerator

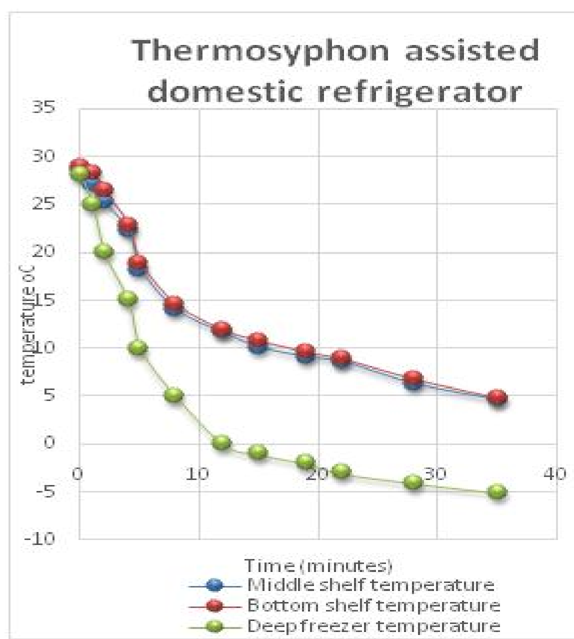

Fig 4 Time vs Shelves temperature of thermosyphon assisted domestic refrigerator

Time taken at different shelves temperatures of thermosyphon in domestic refrigerator is shown in fig 4.1 in the domestic refrigerator, the difference between the middle shelf temperature and bottom shelf temperature is high due to the low convicting medium (air) used. To overcome this disadvantage by thermosyphon assisted refrigerator. In the case of thermosyphon refrigerator the difference between the middle shelf temperature and bottom shelf temperature very low while comparing to the domestic refrigerator.

B) *Comparison of cop of domestic refrigerator and thermosyphon assisted domestic refrigerator:*

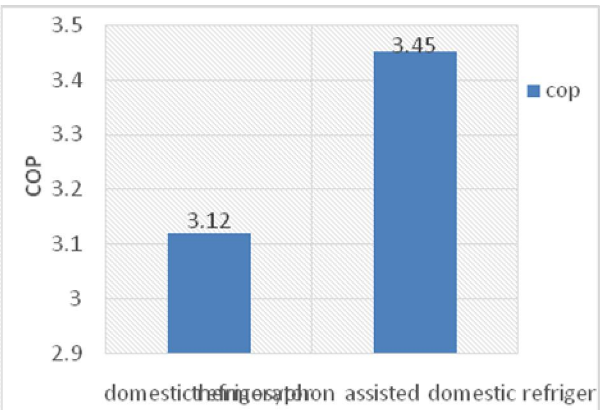

Fig. 5 Comparison of coefficient of performance

The bar graph show coefficient of performances of domestic refrigerator and thermosyphon assisted domestic refrigerator. Here the cop of thermosyphon assisted domestic refrigerator is slightly greater than the domestic refrigerator. This is due additional refrigerating effect of methanol in thermosyphon. Therefore the increase in cop of domestic refrigerator with thermosyphon (methanol as refrigerant) is 3.3% but in case of thermosyphon with water refrigerant refrigerator cop is slightly decreased by 9.9%.

C) *Comparison of defrosting times of domestic refrigerator and thermosyphon assisted refrigerator*:

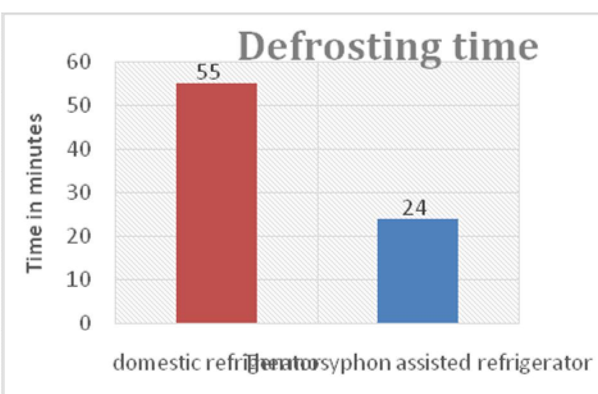

Fig.6 Comparison of defrosting times

For 18 hours continuously run, in domestic refrigerator the defrosting time is very high when compared to thermosyphon assisted refrigerator. Because the methanol present in thermosyphon increases the defrosting rate by rejecting latent heat of condensation enormously

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V. CONCLUSION

Tests were performed on a domestic refrigerator and a thermosyphon made from a copper tube. The results clearly shows thermosyphon assisted domestic refrigerator provides uniform temperature among the shelves of refrigerated space. This system successfully minimizes defrosting time and also provides cooling effect during defrosting time. Thermosyphon with methanol as refrigerant maintains better uniform temperature among shelves of the refrigerated space than water as refrigerant in thermosyphon.The coefficient of performance thermosyphon assisted domestic refrigerator is slightly increased due additional refrigerating effect of methanol in thermosyphon but in case of thermosyphon with water as refrigerant slightly decrease the cop.

- The percentage decrease in bottom shelf temperature of thermosyphon assisted domestic refrigerator is 59.12%.
- The percentage decrease in defrosting time of thermosyphon assisted refrigerator is 50.36% when compared to domestic refrigerator.
- The percentage increase in cop of thermosyphon assisted domestic refrigerator is 10.57%.

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