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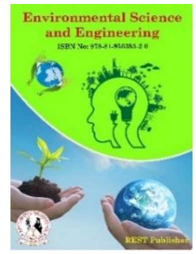

Thermosyphon-Assisted Cooling: A Novel Approach to Enhance Refrigeration in Household Fridges

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Abstract: *Nonuniform chilling in the cabinet, i.e., the upper portion of the refrigerator is at very low temperature than the bottom portion of the refrigerator shelf, and also during defrosting period cooling of food goods is not carried out, is the main problem connected with household refrigerators. Thermosyphons, which use volatile fluid to cool the cabinet uniformly, are a great solution to this problem. Here, heat is transferred from the refrigerator's bottom shelf to the fluid in the thermosyphon, which is then rejected at the evaporator. To prevent food from spoiling and frost buildup on the evaporator coil by maintaining a consistent temperature inside the refrigerator's cabinet.*

1. INTRODUCTION

Nonuniform cooling among refrigerator shelves is a concern in modern refrigeration systems. Large amounts of time spent defrosting with no cooling impact is another issue. The use of a household refrigerator equipped with a thermosyphon can solve this issue. A passive component called a thermosyphon keeps the temperature consistent in the refrigeration unit and reduces the amount of frost that forms on the evaporator coil. One single phase thermosyphon and one two phase thermosyphon are employed in the current study. Two-phase thermosyphons transmit heat by convection and phase change, whereas single-phase thermosyphons rely solely on convection. The working medium in a single-phase thermosyphon is nonvolatile, but in a two-phase thermosyphon it is volatile. Methanol is the volatile fluid and water is the non-volatile fluid in this work's thermosyphon setup.

2. LITERATURE REVIEW

The original experimental investigation by McDonald et al. (1) only looked at the effectiveness of single loops. R-113 and R-11 were used as the working fluids, and the results were the same for both. Loop conductance, which is the inverse of the effective thermal resistance provided by the thermosyphon loop between the heat source and the heat sink, was used to establish the performance curves. Systematic changes were made to the source and sink temperatures, as well as the amount of refrigerant in the system and the angle at which the evaporator and condenser tubes were inclined. The optimal performance of the system was determined by a combination of evaporator dry out and condenser flooding.Using the existing empirical correlations for evaporation and condensation heat transfer coefficients and single-phase and two-phase pressure decreases, Ali and McDonald et al. (2) simulated the performance of thermo siphon loops. The performance characteristics of the three thermosyphon loops created by McDonald and Ali's simulation were found to be in fair agreement with the experimental results.More experimental research on unidirectional and bidirectional thermosyphon loops was done by McDonald and Sampathetal.(3). These studies show that the charge, or amount of refrigerant, plays a significant role in the efficiency of the system.Based on their research into the concentric tube thermosyphon, Seki et al. (4) offered design guidelines for the boiling heat transfer coefficient in annular spaces. The annular zone of the concentric tube thermosyphon is where the refrigerant is boiled off before rising to the condensing section. The inner tube is used to transport the condensed liquid back to the annular region's base.

3. EXPERIMENTAL SET UP &METHADOLOGY

Figure 1: Schematic of the household refrigeration cycle with a thermosyphon aid. The compressor, thermosyphon, condenser, capillary tube, and expansion valve are the primary parts. As can be seen in Figure 3, the thermosyphon is constructed out of copper sheeting. The primary goal of thermosyphon is to keep all of the area in a refrigerator at the same temperature. In theThermosyphon is positioned atop the evaporator in the illustrated configuration of the tested refrigeration system. Thermosyphons also serve to prevent evaporator frost buildup.Assisted home refrigerator thermosyphon schematic Figure 2: Thermosyphon schematic

FIGURE 1. Thermo syphon assisted domestic refrigerator

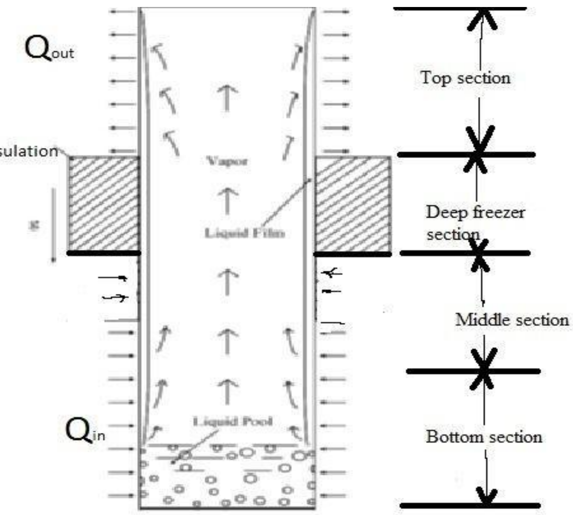

FIGURE 2. Schematic diagram of thermo syphon

Thermosyphon working Heat pipes without an internal wick are depicted in Fig. 2 as two-phase closed thermosyphons. Its construction and design are both straightforward, consisting only of a hollow tube that has been emptied and filled with a working fluid before being positioned vertically. The refrigerator's working fluid is heated at the bottom shelf and evaporates as it rises to the evaporator at the unit's uppermost level. The vapour condenses on the pipe wall because heat is lost in the evaporator. Gravity pulls the liquid back down to the fridge's bottom shelf, and the cycle begins again.An insulated part in the middle, known as an adiabatic section, is also possible. Because both the falling liquid layer and the liquid pool in the bottom of the device contribute in the phase change and heat transmission, the heat transfer mechanisms in the bottom shelf of the refrigerator are more complex than those in the evaporator. Both liquid film and liquid pool heat transfer can occur in a variety of regimes, depending on the magnitude of the wall heat flow. The highest possible heat transfer through a thermosyphon is capped by a number of parameters. When there isn't enough working fluid, dry spots develop on the evaporator's walls, a phenomenon known as dry-out. On the other hand, if there is an excess of liquid, a phenomenon known as "pool flooding" takes place, in which the pool of liquid fills up and subsequently spreads beyond the base section as a result of nucleate boiling. At high vapour velocities, the upward-moving vapour exerts significant shear stress on the falling liquid film, increasing the film thickness or causing the film to totally split from the wall, marking the counter-current flooding limit.

4. EXPERIMENTAL RESULTS

As may be seen in fig. 4.1, the difference in time spent at temperatures on the middle and lower shelves of a residential refrigerator's thermo syphon is large because of the low convicting medium (air) used. Thermo syphon-assisted refrigeration is one solution to this problem. When compared to standard refrigerators, the temperature differential between the middle and bottom shelves of a thermo syphon refrigerator is much smaller.

A) Comparison of refrigerator shelves temperatures

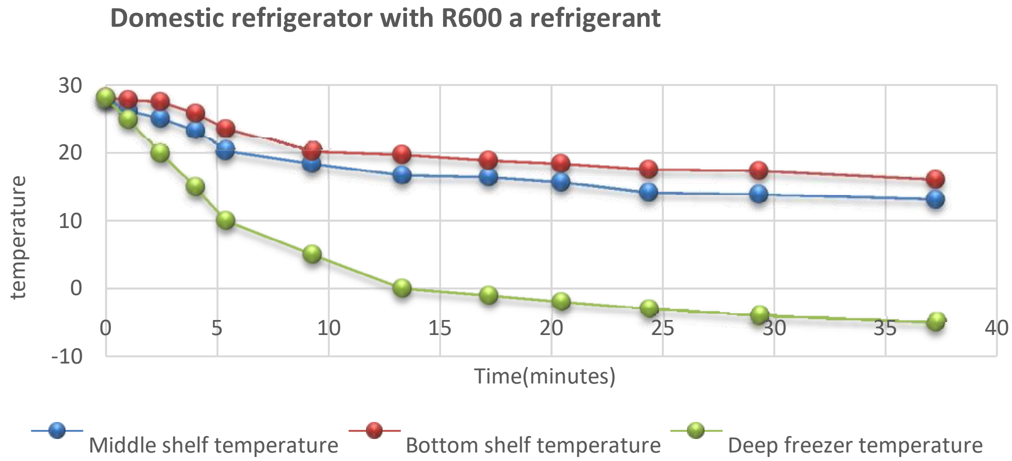

FIGURE 3. Timescales temperature of domestic refrigerator

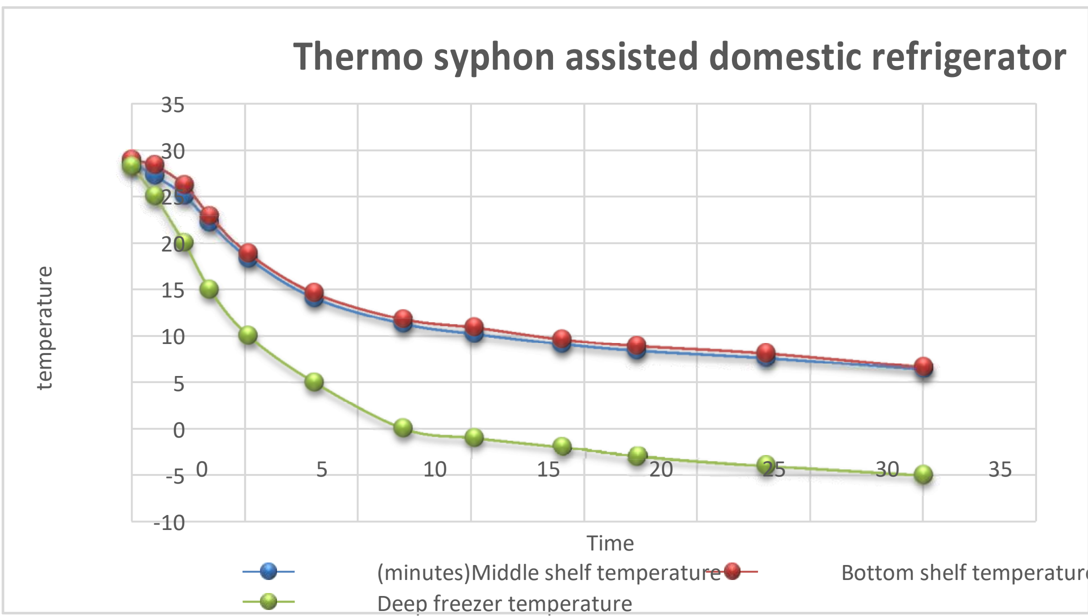

FIGURE4. Time vs Shelves temperature of thermo syphon assisted domestic refrigerator

B) Comparison of refrigerate ants' methanol and water used in thermosyphon:

The following graphs shows, the variation of temperature in the refrigerator cabin by varying refrigerants in thermosiphon.

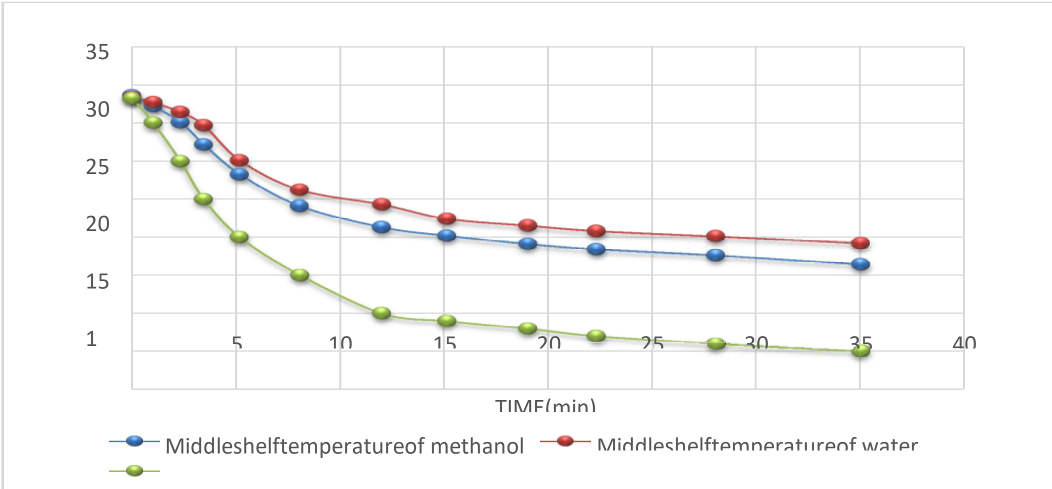

FIGURE 5. Timevs middle shelf temperature of methanol and water

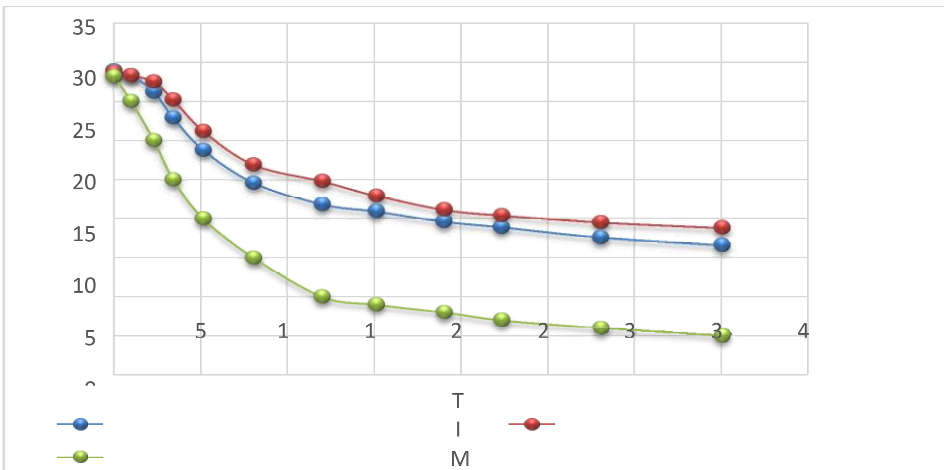

FIGURE 6. Times bottom shelf temperature of methanol and water

This graph illustrates how much more effectively methanol cools the shelves of a refrigerator than water does. Since methanol has a low boiling point, it can rapidly evaporate by absorbing heat from the bottom shelf, while water cannot. Water reduces the temperature of the shelves by transferring heat from the evaporator to the shelves, whereas methanol does so by absorbing latent heat from the environment and delivering it to the evaporator, thereby reducing the cooling rate and increasing the load on the evaporator.

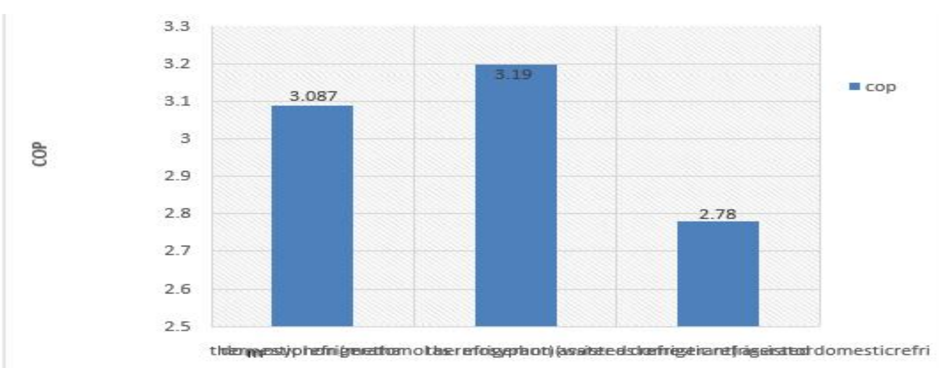

FIGURE7. Comparison of coefficient of performance

The graph compares the efficiency of a standard home refrigerator to that of one aided by a thermosyphon. In this case, the residential refrigerator with a thermosyphon aid has a somewhat higher COP. The added cooling impact of the methanol in the thermosyphon is to blame for this phenomenon. With a thermosyphon (using methanol as the refrigerant), the COPerformance of a standard home refrigerator increases by 3.3%, but it decreases by 9.9% when Usingwater as the refrigerant.When compared to a thermosyphon-assisted refrigerator, the defrosting period in a standard home refrigerator is prohibitively long, clocking in at 16 hours on a continuous run. Thermosyphon dramatically accelerates the defrosting process due to the methanol's ability to reject latent heat of condensation.

*C*omparisonofdefrostingtimesofdomesticrefrigeratorandthermosyphonassistedrefrigerator:

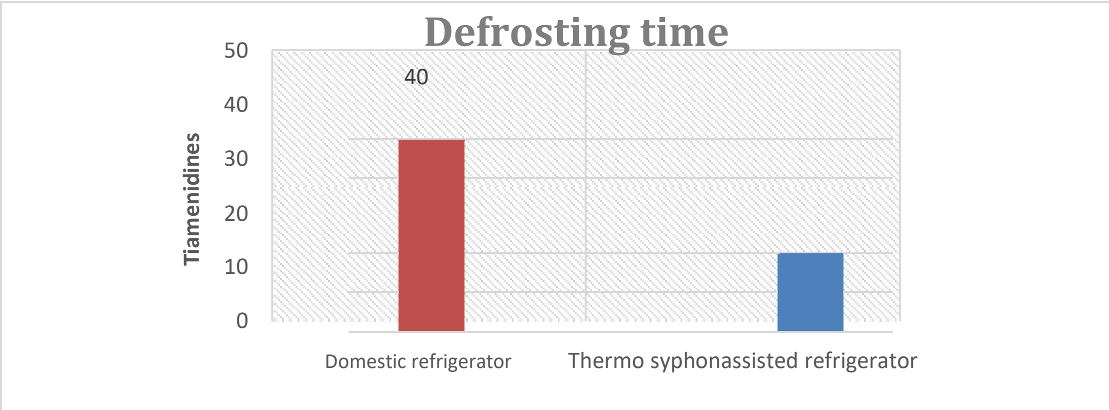

FIGURE 8.Comparison of defrostingtimes

5. CONCLUSION

Both a home refrigerator and a thermosyphon constructed from a copper tube were put through their paces in the lab. The data demonstrates that a residential refrigerator with a thermosyphon aids in maintaining consistent temperatures across all shelves. The added cooling power of the methanol in the thermosyphon causes the coefficient of performance of the residential refrigerator to rise somewhat, whereas the use of water as the refrigerant causes it to fall slightly. Bottom shelf temperatures in residential refrigerators with thermosyphon assistance (using methanol as the refrigerant) drop by 59.01%, whereas those in refrigerators using water as the refrigerant rise by 33.54%When compared to conventional refrigerators, thermosyphon-assisted models require half as much time to defrost.The residential refrigerators that use methanol as a refrigerant have a 3.3% higherCOP than those that use water, while those that use water have a 9.9% lower COP

REFERENCES

[1] U.S. Energy information administration, Annual energy outlook 2015, Data table A4. 2015.

[2] U.S. Energy information administration, COMMERCIAL BUILDINGS ENERGY CONSUMPTION SURVEY (CBECS),2016.

[3] U.S .Environmental protection agency and U.S. Department of Energy ENERGY STAR [cited2016,may12]; Available from:www.energystar.gov.

[4] Dunn, P.D. and D.Reay, Heat pipes. 2012: Elsevier.

[5] Lukitobudi, A.R.,etal., design, construction and testing of a thermo siphon heat exchange cryo medium temperature heater cover in bakeries. Heatre cover systems and CHP,199.15(5):p.481-491.