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Experimental Analysis of Domestic Refregirator by Using Spiral Shape Condenser

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ABSTRACT

Most of the household refrigerators work on the vapor compression refrigeration system which are holding high coefficient of performance. The research article elaborates work about COP enhancement of domestic refrigerator by making alternative arrangement for condenser. The maximum utilization of thermal energy is achieved by proper utilization of Heat Exchangers, and selection of temperature gradient. The purpose of paper is to compare the COP of refrigerator by using spiral shaped condenser and the refrigerant R-134a with commercial refrigerator. It was observed that the COP of VCRS noticeably increased by using spiral type condenser with enhance rate of Heat Transfer through Heat Exchanger.

Keywords: Condenser, COP, Refrigeration, Heat Rejection.

I. INTRODUCTION

Most of the domestic and commercial refrigerators are operates on 'Vapor-Compression' cycle and run for normal COP value which holds the scope of improvement with alteration made in components assembled in system. Energy recovery is the prime requirement today to optimize energy consumption. The maximum utilization of thermal energy is achieved by properly designed Heat Exchangers, and selection of temperature program. Figure 1 shows the schematic diagram of components for typical vapor-compression refrigeration system. Basic components of refrigeration system as shown in the below Fig., they are compressor, Condenser, Expansion valve, evaporator.

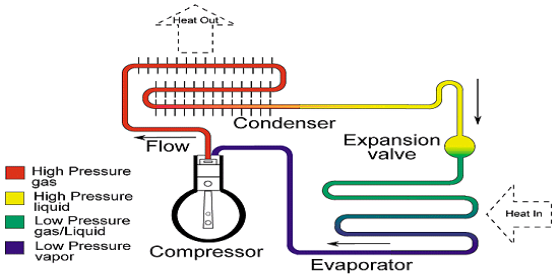


Figure 1

Refrigerant effect is obtained at the evaporator, low pressure liquid refrigerant flows in the coils of evaporator and absorbs heat from product; the refrigerant vaporizes and leaves for compressor. From Figure, the vapour is compressed at constant entropy and exit compressor as a vapour which holding very high temperature. The liquid refrigerant goes through expansion valve/Throttle valve, where its pressure decreases abruptly, causing flash evaporation and auto-refrigeration of less than half of the liquid. The resulting refrigerant vapour returns back to the

compressor inlet to complete the thermodynamic cycle and so on. This report work elaborates the heat exchanger i.e. condenser. Which is mainly classified based on the shape of the coils, type of flow of refrigerant. Condenser is a device or unit used to condense a sub-stance from its gaseous to its liquid state, by cooling it. Lots of modifications and exploration has been done on refrigeration system in order to improve the efficiency and ease of getting cooling effect. P.G. Lohote et al. [1] contributed by using spiral condenser to raise COP of refrigerator to the value that was never before. The Experimental work centric about performance study of spiral shaped condenser used in refrigerator holding 165 litters' capacity. B. Santosh Kumar et al. [2] performed the experimental investigation of vapor compression refrigeration system with spiral shaped condenser. Experiment was done on kelvinator refrigerator of 165 liters and hermitic compressor is used. Bilal A. Qureshi et al. [3] studied experimental observation on the impact of fouling on the condenser of a vapor compression refrigeration system. An experimental study of condenser fouling factor on some performance characteristics and properties of a simple vapor compression sys-tem is presented. It can be conclude that due to fouling heat transfer rate of condenser was decreases.

II. EXPERIMENTAL WORK

The condenser is one of most important component of Vapor compression refrigeration system which contributes lot in the overall system performance. As function of Condenser is dissipating the heat absorbed by refrigerant during the process of evaporation and compression. The refrigerant COP is the function of its operating temperature, the current work undertakes modification of condenser geometry and thus through effective temperature regulation maintained, system COP would be high. The project work is centric about, installation of spiral and micro channel shape base condenser to the refrigerator holding 165 Liters capacity.

The specification of the spiral shaped condenser and the coil diameter is shown below:-
Condenser coil diameter (Copper):- 6.35 mm
Length of Condenser Coil (Copper) :- 8.5 m
No. of Turns :- 7 Turns
Refrigerant Type:- R-134a

Figure 2. Actual picture of experimental setup

III. PROPOSED METHDOLOGY

To increase the COP of the refrigeration system many changes can be done in the design of condenser and evaporator. As we increase the effectiveness of the condenser, ultimately COP of the system increases. Effectiveness of the condenser can be increased by many methods some of them are, Geometry of the condenser coil, Increase the surface Area, thermal Conductivity of the tube material, Fin spacing After literature survey we felt that there is chance to increase the effectiveness of the condenser considering the geometry of the condenser tube.

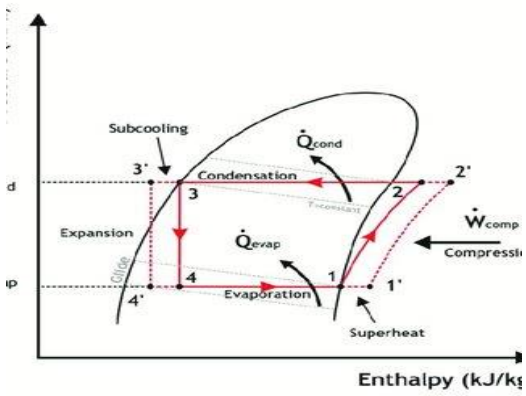


Figure 3

IV. EXPERIMENTAL PROCEDURE

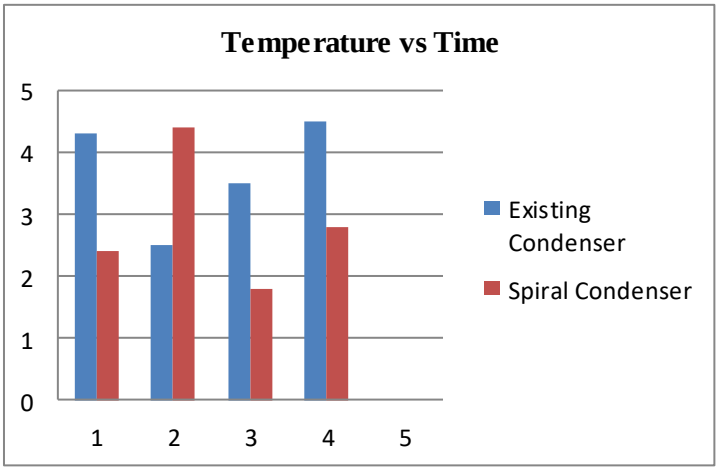
The following procedure is intended to build an experimental set up for Vapor compression refrigeration system

- Domestic refrigerator working on Vapor compression cycle with holding capacity (165 Liter) is used for study.
- Pressure and temperature sensors are fixed at the point of compressor entry and exit too.
- Conventional condenser replaced by Spiral shaped condenser coil.
- R-134a refrigerant is charged in to VCR system
- Switch ON the refrigerator system and observations are noted from Pressure gauge and temperature indicators for respective temperature readings.
- The performance of the existing system, with Spiral condenser is investigated with respect to set of observations.
- COP is investigated with the help of P-H chart
- The results are tabulated for Existing, Spiral condenser based system
- The Compression of spiral shaped Condenser VCRS is done with respect to commercial VCRS.

V. CALCULATION AND RESULT

Existing Calculation-

- COP (Copper) = 3.57
- Heat Rejection in Condenser = 206 KJ/Kg
- Theoretical Power Consumption of Compressor = 0.978 KW
- Heat Transfer Rate = 18.7 KW
- COP= (h_1-h_4) / (h_2-h_1)
- $h_1 = hg@T_1$
- $S_1 = S_2$
- $h_2 = h_{g@\ pr.conden} + C_p [T_{sup} - T_{sat@pr.conden}]$
- $h_3 = h_{f@}T_3$
- $h_4 = h_{f@}T_4$



Gharp 1

VI. CONCLUSION

The current work is centric about performance study of spiral shaped condenser used in refrigerator holding 165 liters' capacity. The data obtained from experimental set up used in analyzing performance of spiral shaped condenser used as a part of vapor compression system. With introduction made for spiral shape condensers. COP value found increased by 5.06 % over the conventional refrigeration system

- With the help of our arrangement heat loss increases via conduction-convection-conduction-radiation.

With this setup we are increasing COP of refrigerator with little increasing power consumption.

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