PERFORMANCE ENHANCEMENT OF VCR CYCLE BY MODIFICATION OF GEOMETRY OF EVAPORATOR TUBES OF EVAPORATOR

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ABSTRACT

The present study aims to improve shape of the evaporator tubes of the evaporator in a VCR test rig. In the existing VCR refrigerator circular cross-section of the evaporator tubes are used to form the evaporator coil of the refrigerator. In the present work ,change in the geometry of the evaporator tube are studied , where in the cross-section of tube is varied form namely circular geometry (round) ,circular with V-shape notch, circular with Square shape notch and circular with U-shape notch profiles are studied and CoP of setup is experimentally investigated. Our result shows that the CoP of evaporator coil having geometry of round with V-notch and round with U- notch is higher than CoP. of the plain coil and the CoP of the evaporator coil having geometry round with square shape notch is lower than CoP of the round tube evaporator. From experimental investigation it is found out that the maximum CoP achieved by the plain tube coil is 1.74 and by U- notched evaporator profile it is 1.99. Hence, we can conclude that, evaporator having geometry round with U shape notch evaporator coil is most effective out of the four profiles studied.

Keyword : - *Coefficient of Performance, Vapour Compression Cycle, Evaporator Coil .*

1. INTRODUCTION

Domestic refrigerators are used to store food and other items which are perishable at room temperature over a period of 10 decades now. The refrigerator is among the home appliances that use the most of energy. The majority of these refrigerators are based on vapour compression technology, constituting one of the principal energy consumers whose incidence is increasing in less economically developing countries .In developed countries vapour compression systems are responsible for around 30% of overall energy consumption. In last few years, researchers have undertaken significant efforts to improve energy efficiency of home appliances. At the same time refrigerator is one of the most manufactured appliance due to being indispensable in home. The development of world refrigerator industry require a wide study of all factors that are in one way or another contribute to achieve greater energy efficiency in accordance with the application of and compliance with the technical norms regarding energy consumption, green house gas emission, environmental impact, etc. There is a variety of mechanisms that may increase refrigerator energy efficiency that have been widely studied by researchers the most relevant are: improvement in compressor performance, adequate thermal isolation, improvement in heat exchanger design, and implementation of optimum control in refrigerator operation. It is easy to suppose that with any improvement in refrigeration performance it is possible to achieve savings. Improvement in the design of the evaporator coil which leads to centrifugal forces inside the modified tubes to improve radial heat transfer in addition to axial heat transfer. In other words generation of such secondary phenomenon in the modified tube significantly improves heat transfer rate per unit volume compared to straight tubes.

Todrov et.al. [1] developed a design of "table top" refrigerator evaporator. Four different geometries of serpentine curve were examined. The conventional geometry is also modelled in order to compare the performance. In the present study only the shape of serpentine axis is modified. The CFD meshed models is built. Variant C3 shows best results with 7% increased heat flow rate. Eiamsa-ard et.al., [2] experimentally investigated, heat transfer, friction factor and thermal performance behaviors in a tube equipped with the combined devices between the twisted tape (TT) and constant/periodically varying wire coil pitch. The experiments were conducted with Reynolds numbers ranging from 4600 to 20,000 using air as the medium fluid. Over the range investigated, the highest thermal performance factor of around 1.25 is found by using DI-coil in common with the TT at lower Reynolds number. Garad et.al. [3] studied numerical analysis of square notched twisted tape inserts in a tube by varying pitch with air as working fluid. The variation of Reynolds 35000-45000 . The results shown that heat transfer augmentation with square notched twisted tape double slot is about 19.57%, 44.31%,75.59% as compared with plane tube. Kumbhar et.al. [4] studied using "High performance tube manufacture's software" and "Compressor selection software the effect of various parameters on working condition of chiller. With increase in SST we will get better refrigerating effect. For 1º increase in SST, cooling capacity increases nearly by 4%. There is almost 3.61% increase in COP per ºC increase in SST. Waltrichet.al.[5] studied Accelerated Flow Evaporator ,the air side cross sectional area decreases with the distance from the air flow inlet, accelerating the air as it flows across tubes and therefore improving the air side local heat transfer coefficient .None of the AFE samples performed better in terms of UA than their baseline counterparts ,which is an indication that the amount of surface area is most important factor in determining the magnitude of UA. All AFE samples have pressure drop greater than their respective baseline counterparts. Tamna et.al., [6] experimentally investigated heat transfer enhancement in a round tube by insertion of double twisted tapes in common with 30° V-shaped ribs. The V-ribbed twisted tape with BR¼0.19 yields the highest heat transfer and friction factor. However, the maximum thermal enhancement factor is about 1.4 for the V-ribbed twisted tape at BR¼0.09 but is around 1.09 for the twisted tape with no rib. Suryawanshi et.al., [7] experimentally investigated heat transfer coefficient by using twisted tape and triangular fin type inserts in forced convection. The length and width of insert was 1000 mm and 16 mm for twisted tape. For circular fin type insert, the pipe of 9 mm diameter is used, on which 6 mm equilateral triangles are mounted at 90° as a fin. It is found that there is an increase in heat transfer coefficient with respect to Nusselt number. The value of friction factor depends on the Reynolds number. It is independent of any other variable.

2. EXPERIMENTAL SETUP

The tests were conducted on a VCR test rig it consist of Compressor, Condenser, Capillary tube, and evaporator and measuring instruments. Generally, in evaporator of any household refrigerator a plain circular coil is used and heat transfer takes place through the round sectional area of the coil. If we change the area by changing the shape of the evaporator coil the heat transfer will increase which will increase the CoP of the system. In this study we changed the section of evaporator coils by giving notches namely V shaped notch, U shaped notch, square shape notches are given and it is compared with the performance of plain tube.

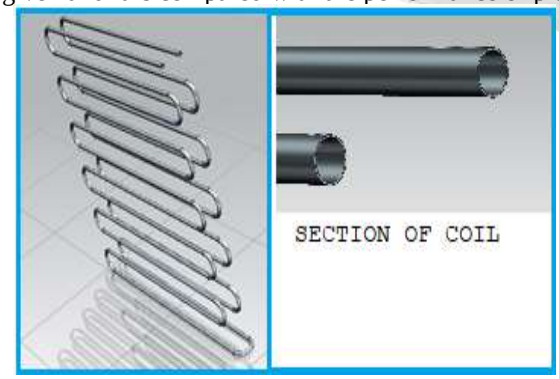

Fig 1. Modified evaporator coil with V- notch.

Fig 2. Modified evaporator coil with V- notch.

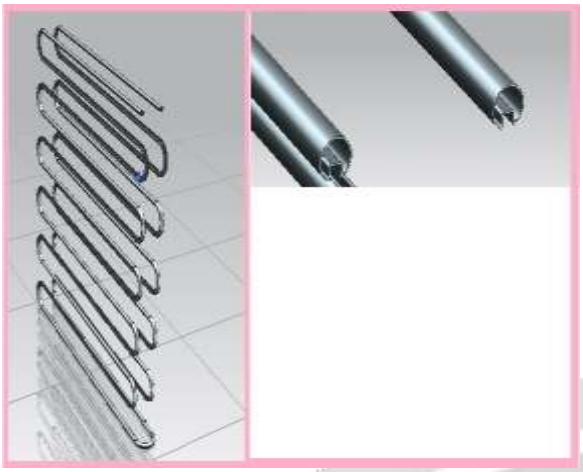

Figure 3. Evaporator coil with Square notch.

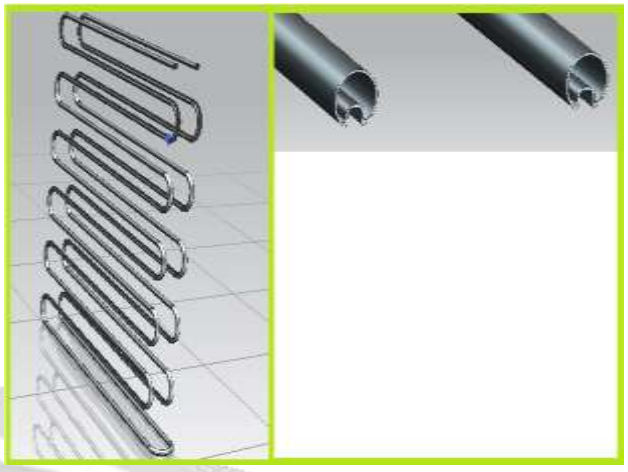

Figure 4. Evaporator coil with U- notch

3. RESULT ANALYSIS

3.1 Evaporator with plain tube evaporator coil

The study is performed on copper coil having diameter 6.34 mm. The test is carried out initially on evaporator having plain tube. It is found that CoP increases initially and it reaches 1.8 and after 35 minutes of operation the maximum CoP obtained is 1.74.

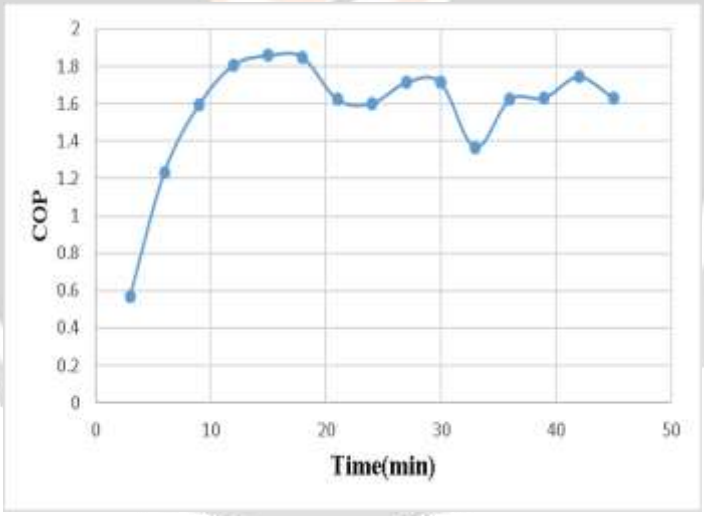

Chart-1 COP VS Time for evaporator without enhancement

4.2 Evaporator with square notched evaporator coil

Then the experiment is repeated with plain coil with square notch throughout its length, as the graph indicates the *CoP* of the system increases steadily and it remains constant after 30 minutes of operation. The Coefficient of Performance achieved by the setup is 1.60 which is less than evaporator with round tube. Hence, it can be said that square tube evaporator is less effective as compared with plain tube evaporator.

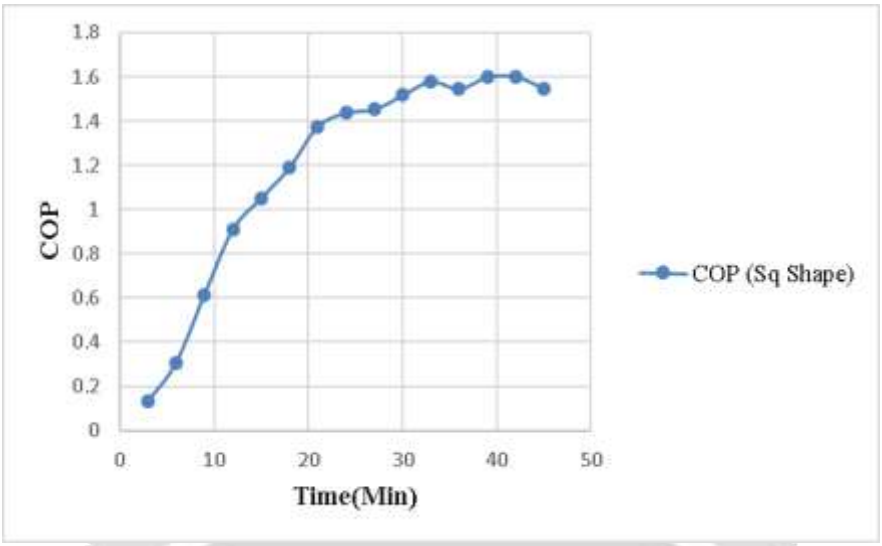

Chart-2 COP VS Time for evaporator with square notched profile

4.3 Evaporator with V-notched evaporator coil

The test is carried out on round tube with V- shape notch ,it is found that the *CoP* increases steadily up to 30 minutes and the maximum *CoP* achieved by the system is 1.86 and it is greater as compared with the regular evaporator.

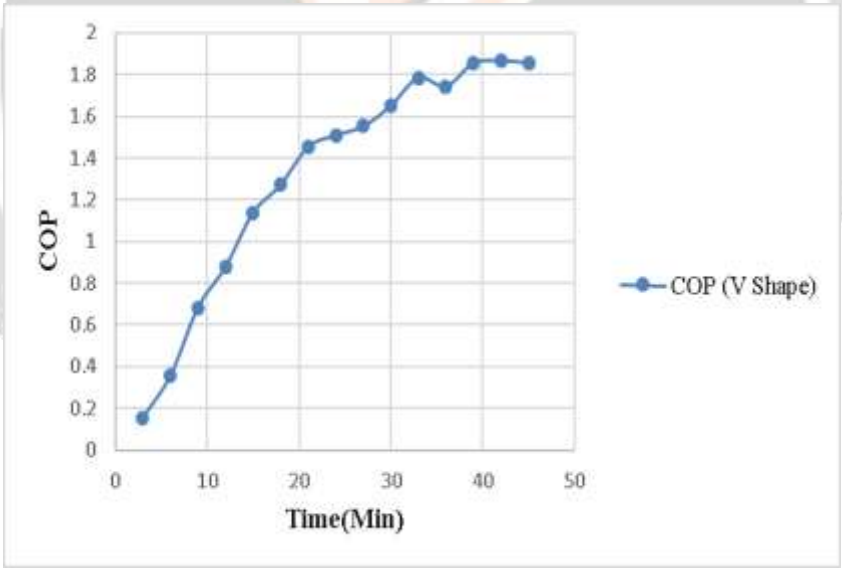

Chart-3 COP VS Time for evaporator with V- notched profile

4.4 Evaporator with U-notched evaporator coil

Tests are conducted on VCR test rig with an evaporator having copper evaporator coil with a U shaped notch. The *CoP* of the system increases steadily and the maximum *CoP* of the system is 1.99. The *CoP* of the modified evaporator coil with U-notch is maximum out of the four profiles studied.

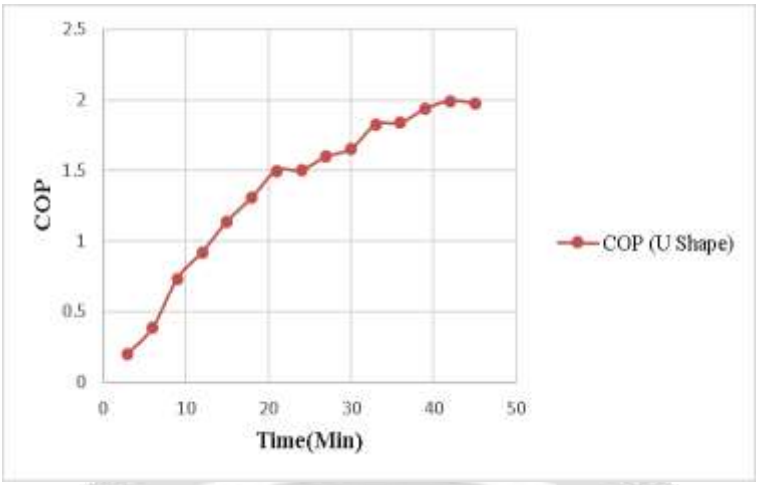

Chart-4 COP VS Time for evaporator with U- notched profile

4.5 Comparison of Performance of modified profiles

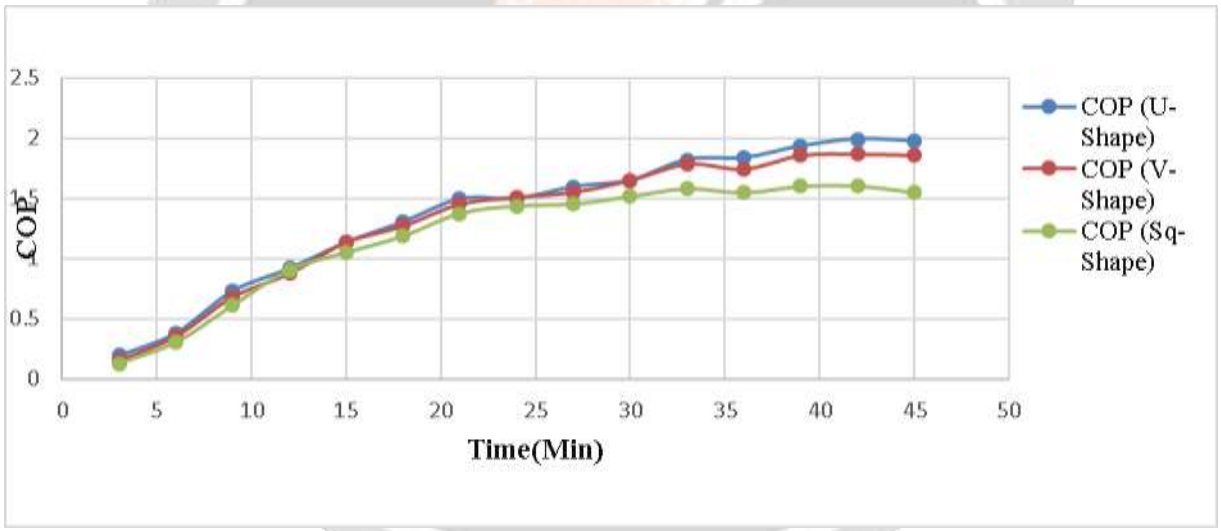

Chart-5 COP VS Time for evaporator modified profiles.

The comparison of the performance of all three modified profiles of evaporator coils is shown in the graph. It can be clearly seen that the Coefficient of Performance of Round tube with square notch is minimum and that of the evaporator with U shaped notched evaporator coil is maximum.

4. CONCLUSIONS

The plain evaporator coil is modified by providing notches all over the length of the coil. In this study three modified geometries are tested experimentally and their performance is compared with the evaporator coil having plain tube evaporator. It is found that the maximum Coefficient of Performance achieved is 1.99 by evaporator having U-notched evaporator coil whereas minimum *CoP* of 1.60 is obtained with evaporator having square notched evaporator coil, hence it is least effective out of the profiles studied. The regular plain tube evaporator gives

CoP of 1.74 and *CoP* of V notched coil is 1.86 which is higher than plain tube coil. Hence, we can conclude that evaporator having U- notch is most effective while evaporator with square shaped notch is least effective.

5. REFERENCES

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