Journal of Material Science and Mechanical Engineering (JMSME)
Print ISSN : 2339-9095; Online ISSN : 2393-9109; Volume 2, Number 6; April – June, 2015 pp 18 – 20
Krishi Sanskriti Publications
http://www.krishisanskriti.org/jmsme.html

# Experimental Investigation of Performance of VCRS with and without Diffuser

**Rishabh Singh[1*], Navin[2] and Dinkar Prasad Singh[3]**

*1,2,3Department of Mechanical Engineering,* Lovely Professional University Phagwara, Punjab (India) -144402
*E-mail: 1rishurishabh70@gmail.com*

**Abstract—***Time has its changing effect not only on the human living standard but also effects the modern technology in the field of refrigeration and air conditioning. In order to improve the performance of the VCRS system it become necessary to modify the system. It can either be increased by decreasing the compressor work or increasing the refrigeration effect or by the combination of both. So for that purpose diffuser devices are provided in many refrigeration systems to increase the pressure and as well temperature coming from the compressor which ultimately reduces the compressor work. This paper presents the investigation on the effect on the performance of the VCRS system by employing diffuser after the compressor exit. Refrigerant R134a is selected for this investigation. Experimental results show that the COP of simple vapor compression system using diffuser is greater than the COP of vapor compression system without it. Thus we can conclude that COP of VCRS using diffuser increases due to reduction in the compressor work.*

**Keywords:** *VCRS, diffusers, COP*

## 1. INTRODUCTION

Refrigeration is defined as absorbing the heat from an enclosed space and rejecting it to the atmosphere in order to lower the temperature of that space. There are various kind of refrigeration cycle which is being used but the most often is vapor compression refrigeration cycle (VCRS). It's been used in cold storages, domestic refrigeration, industrial refrigeration, transport refrigeration, etc. Which shows its utilization in every aspects of life, thus the need of advancement and modification comes into play.

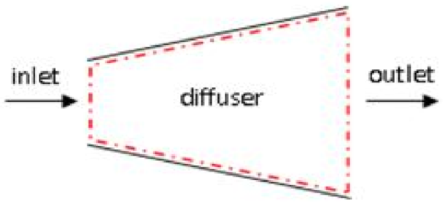
The condenser in VCRS removes the heat from high pressure vapor refrigerant and converts it into high pressure liquid refrigerant. The refrigerant flows inside the coils of condenser and there the phase change occurs at the constant pressure and temperature, which results in high pressure liquid refrigerant. The high pressure liquid refrigerant flows through the capillary tube which engender the expansion of the refrigerant causing the pressure drop of it. Now, low pressure refrigerant flows through the evaporator which absorbs the heat from the object which we want to keep cool.

The efficiency of refrigerator is expressed in terms of Coefficient of performance (COP). It is calculated by dividing refrigeration effect by the work done by the compressor. Thus to increase the COP many developments have been made. In this investigation various diffusers are being used which helps in superheating as well as sub cooling. In Superheating refrigerant enters in compressor in complete vapor phase which helps in increasing the enduringness of the components as refrigerant in liquid phase even in small amount can seriously damage the compressor. Whereas in Sub cooling process further rejection of heat from liquid refrigerant coming out of condenser is done so as to improve the efficiency of condenser which ultimately increases the overall refrigeration effect of the system.

Diffuser is the static device which helps in increasing the pressure of flowing fluid by converting its kinetic energy. Generally the compressor in vapor compression refrigeration system increases the velocity of the refrigerant at its outlet which causes damage to the condenser as well as affect its efficiency of rejecting heat to the environment due to the turbulences. The undesirable spattering of refrigerant to the condenser is also known as "liquid hump". To avoid the problems of high velocity refrigerant diffuser is used at condenser inlet which helps in losing the kinetic energy of the refrigerant so as to provide homogeneous supply to the condenser as well asmaximizes static pressure recovery. This pressure recovery helps compressor to do less work for the same refrigerating effect. Hence, power consumption of the compressor will be reduced which ultimately improves the system efficiency. Diffuser causes the increase in pressure as well as temperature of the refrigerant which helps in more heat transfer between the condenser and the. So, the amount of heat rejected from condenser will be increases. Which also signifies that the smaller condenser can also be used to remove the same amount of heat.

## 2. GEOMETRY OF THE DIFFUSER

The cross-sectional area of diffuser should be increasing when the refrigerant is flowing from compressor to condenser, since the refrigerant velocity at the compressor outlet is sub-sonic (any speed lower than the speed of sound within a sound propagating medium).



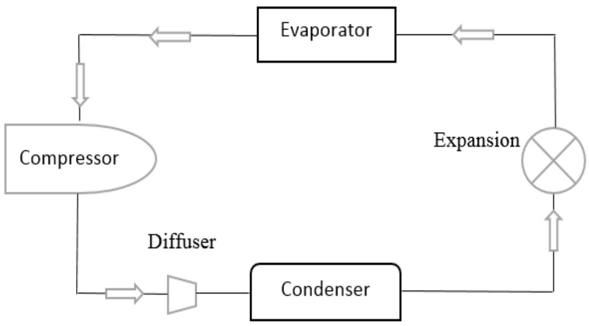

## 3. EXPERIMENTAL SETUP

Description of experimental setup:

In this experiment we have concentrated our work on the performance of VCRS by using diffuser at the inlet of the condenser so as to increase the performance of the system.

The setup consist of a simple vapor compression system having an evaporator, compressor, condenser, capillary tube and a diffuser.

Ammeter and voltmeter are used to measure the electrical current and voltage of input power respectively. The bourdon pressure gauges are used to measure the inlet and outlet pressure of compressor. Temperatures of refrigerant and the ambient air at different points are measured by use of digital thermometer. Before temperature measurement, the surface of the tubes are polished for removing any type of dust or rust and then the thermocouples are laid own onto the surface. Insulation tapes are wrapped around the copper tubes to prevent any heat losses to ambient air.




## 4. OBSERVATION TABLE

| PARA-METERS | SYMBOL | UNIT | VCRS SYSTEM | WITH DIFFUSER |
|---|---|---|---|---|
| Compressor Inlet Temp. | $T_1$ | $^0C$ | 7 | 7 |
| Compressor Inlet pressure | $P_1$ | Bar | 2.13 | 2.13 |
| Condenser Inlet Temp. | $T_2$ | $^0C$ | 58.7 | 59.8 |
| Condenser Inlet pressure | $P_2$ | Bar | 15.93 | 16.62 |
| Condenser Outlet Temp. | $T_3$ | $^0C$ | 51.4 | 51.4 |
| Condenser Outlet Pressure | $P_3$ | Bar | 15.93 | 16.62 |

## 5. CALCULATION

H1 (enthalpy of refrigerant leaving evaporator and entering compressor)

H2 (enthalpy of refrigerant leaving compressor and entering condenser)

$H2'$ (enthalpy of refrigerant leaving compressor and entering condenser via diffuser)

H3 (enthalpy of refrigerant leaving condenser and entering capillary)

H4 (enthalpy of refrigerant leaving capillary and entering evaporator)

$H4'$ (enthalpy of refrigerant leaving capillary and entering evaporator via diffuser)

**For Simple VCRS:**

H1= 369.34375408242

H2= 412.79907904365

H4= 273.718796

COP= H1-H4 / H2-H1

= 369.34375408242-273.718796 / 412.79907904365-369.34375408242

= 95.624958082 / 43.455324961

= 2.20053487502= **2.20** (approx.)

**For VCRS with Diffuser**

H1= 369.34375408242

$H2'$= 400.26667378579

$H4'$= 273.703064

$COP = H1 - H4' / H2' - H1$

$= 369.34375408242 - 273.703064 \quad / \quad 400.26667378579 - 369.34375408242$

$= 95.640690082 / 30.922919703$

$= 3.09287386187 =$ **3.09** (approx.)

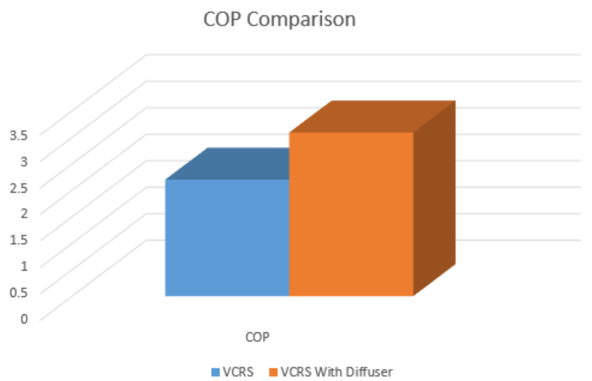
## 6. RESULT AND DISCUSSION

Based on the experimental results, thermodynamic properties of the refrigerant at different points in the cycle are obtained using the P-H chart of refrigerant R-134a and the parameters such as mass flow rate, cooling capacity and COP of the system are calculated from the equations:

a. Compressor Work $W_c = V * I = m_{ref} * (H2 - H1)$
b. Mass flow rate of refrigerant $m_{ref} = W_c/(H2 - H1)$
c. Cooling effect produced $Q_r = m_{ref} * (H1 - H4)$
d. $COP = Q_r / W_c$

Where,
H2 = enthalpy of refrigerant at exit of compressor in kj/kg
H1 = enthalpy of refrigerant at inlet of compressor in kj/kg
H3 = enthalpy of refrigerant at exit of the condenser in kj/kg,
h4 = enthalpy of refrigerant at entry of evaporator in kj/kg

The flow of refrigerant through diffuser led to the conversion of kinetic energy into pressure energy and thus the increase in temperature also occur, this is due to the lack in dissipation of heat energy to the surrounding because of less time. Thus, while calculating the COP with and without diffuser we came to that using the diffuser is very effective since the COP of the VCRS system increases gradually from 2.20 to 3.09




## 7. CONCLUSION

Objective of this study was to compare the performance of Diffuser VCRS with simple VCRS for R134a refrigerant. From the above data it can be concluded that diffuser can be used to improve the performance of the system in case of refrigerant R134a.And the diffuser helps the compressor in increasing the pressure which ultimately reduces the compressor work or for the same pressure output smaller compressor can also be used.

## REFERENCES

[1] M Yari and M Sirousazar, Performance analysis of the ejector-vapor compression refrigeration cycle, Part A: Journal of Power and Energy, Vol. 221, No. 8, December 2007, pp. 1089-1098.
[2] A. Selvaraju, A. Mani, Analysis of an ejector with environment friendly refrigerants, Applied Thermal Engineering, 2004, pp. 1-12.
[3] Mark J. Bergander, New Regenerative Cycle for Vapour Compression Refrigeration, Final Scientific Report, DOE Award Number: DE-FG36-04GO14327, 30th Sept. 2004 to 30th Sept. 2005.
[4] M. A. Akintunde, Validation of vapour compression refrigeration system design model, American Journal of Scientific and Industrial Research, Vol. 2, No. 4, 2011, pp. 504-510.
[5] M. A. Akintunde, Theoretical design model for vapour compression refrigeration systems, A.S.M.E., Vol. 73, No. 5, 2004, pp. 1-14.
[6] P N Ananthanarayanan. Basic Refrigeration and Air Conditioning. Tata McGraw-Hill, 2005.
[7] R. J. Dossat and T. J. Horan. Principles of Refrigeration, Prentice-Hall International Inc., New Jersey, USA, 2002.
[8] Yunus A. Cengel and Michael A. Boles. Thermodynamics An Engineering Approach. Tata McGraw-Hill, 2003.
[9] C. O. Adegoke and M. A. Akintunde, An Experimental Study ofHunting in Evapourators, A.U. J.T., Vol. 10, No. 1, Jul.-2006, pp. 45-51.
[10] BukolaOlalekanBolaji, Effects of Sub-Cooling on the Performance of R12 Alternatives in a Domestic Refrigeration System, Thammasat International Journal Science and Technology, Vol. 15, No. 1, January-March 2010, pp. 12-19.
[11] Experimental Analysis of Vapour Compression Refrigeration System with Diffuser at Condenser InletR. T. Saudagar, U. S. Wankhede International Journal of Engineering and Advanced Technology (IJEAT) ISSN: 2249 – 8958, Volume-2, Issue-4, April 2013