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Experimental investigation of vapour comparision refrigeration cycle using R134a

Kirit L. Kachhela[1],Sharad K. Chhantbar[2]

[1]MechanicalDepartment, Sigma Institute of Engineering
[2] MechanicalDepartment, Sigma Institute of Engineering

Abstract —This study is carried out to understand the effect of operating parameters like condensing pressure evaporator pressure and mass flow rate of refrigerant on the performance of the system. Its observed that beyond certain range of each parameter results in to degradation of performance. Pressure lift in the system should kept in range of 1000 kpa otherwise that results in increment in superheating and throttling loss which ultimately reduces performance of the system. Mass flow rate of refrigerant should kept in range of 1 to 1.5 kg/s to operate this system efficiently

Keywords-*VCRS, COP, Experimental, Comparison, operating parameters*

I. INTRODUCTION

Vapor Compression refrigeration (VCR) system is the most common refrigeration system used for domestic as well as for commercial purpose. Basically this is energy consuming system and operating this system at optimum point so that it results into optimum usage of energy. Performance of VCR system depends on operating parameters like operating pressure and mass flow rate of refrigerant. Engineering Equation Solver (EES) is very good tool for analyzing VCR system. This tool makes analysis and optimization of VCR system much simpler than other tools.

Performance of VCR system is measured in term of Coefficient of Performance (COP), which is the ratio between refrigerating capacity and electrical power supplied to the compressor. Fig. 1 shows a schematic diagram of a vapour compression refrigerator, which consists essentially of a hermetic reciprocating compressor, an evaporator, a condenser and a capillary tube. These components are connected by pipelines in which a refrigerant with suitable thermodynamic properties circulates.[1]

The p-h diagram shown in Fig. 2 is frequently used in the analysis of vapour compression refrigeration cycle. In the refrigeration system, the representative performance characteristics are compressor power(Wc, kW), refrigerating effect (*qe*, kW) and Coefficient of Performance (COP). Fig. 3 shows the T-s plot for the VCRS[1]

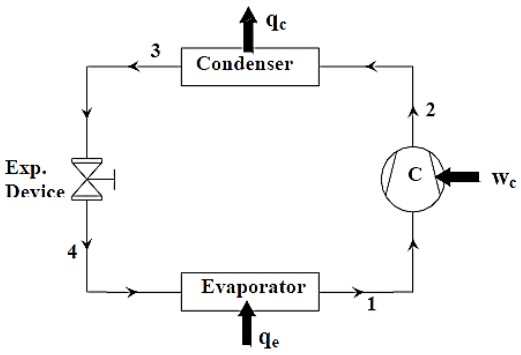

Figure 1- Schematic of VCRS[7]

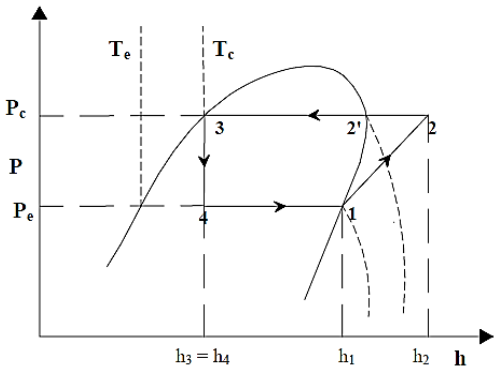

Figure 2- p-h chart[7]

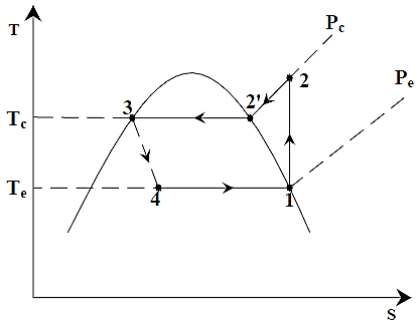

Figure 3- T-s chart[7]

II. METHODOLOGY

This VCRS can be analysed on the basic of COP this system can achieved. COP is nothing but the performance parameter for energy transferring devices like VCRS.

Refrigeration effect produce by any VCR system is given by [6]

$$q_e = \dot{m} * (h_1 - h_4)$$

Heat rejected in condenser

$$q_c = \dot{m} * (h_2 - h_3)$$

Compressor work

$$W_c = \dot{m} * (h_2 - h_1)$$

$$COP_{refrigeration} = \frac{q_e}{W_c} = (\frac{h_1 - h_4}{h_2 - h_1})$$

$$COP_{heat\ pump} = \frac{q_c}{W_c} = (\frac{h_2 - h_3}{h_2 - h_1})$$

Where,

$\dot{m} = mass\ flow\ rate\ of\ refrigerent\ in\ \frac{kg}{s}$,
$q_e = refrigerating\ effect\ in\ kW$,
$q_c = heat\ rejecteed\ in\ condensor\ in\ kW$,
$W_c = compressor\ work\ in\ kW$

III. EXPERIMENTAL WORK

Experimental work was carried out on VCR system using R134a as refrigerant. This system consists of one evaporator, one condenser with reciprocating compressor. Separate thermocouple is provided at the exit of each component so that temperatures can be measured. There are two pressure gauges are installed in to the system to measure evaporator and condenser pressure. Fig. 4 shows experimental setup of VCR system which is under study.

By carrying out the experiment, certain results are being record and these are used as input parameters for analysing system in EES.

Table1. Input parameters

Condenser pressure, PSI	Evaporator pressure, PSI	Temperature, ^{0}C				Mass flow rate of refrigerant, LPH
		Tei	Teo	Tci	Tco	
215	65	4.2	13.6	58.7	35.3	62.5

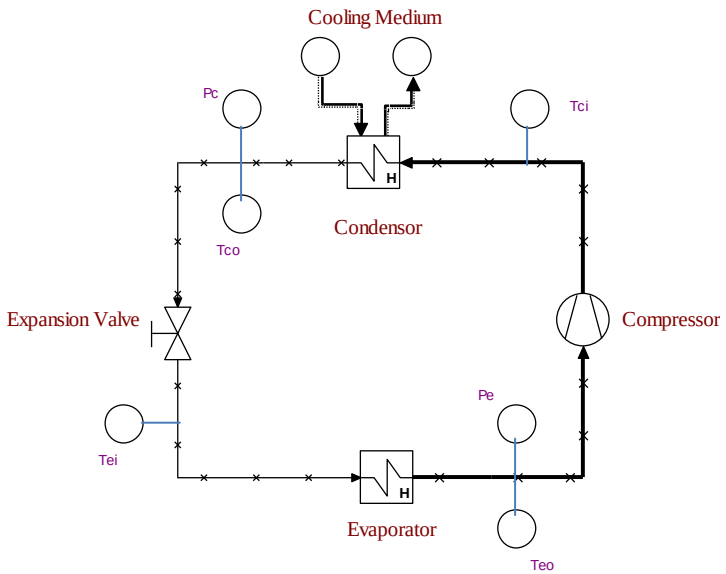

Figure 4. Experimental setup

IV. RESULTS AND DISCUSSION

By generating coding and then by applying different operating condition in EES using input parameter from Table 1 , performance of VCR system is observed and some important conclusions are made. In first set of reading, condenser pressure is kept constant and evaporator pressure is reduced and in second set, evaporator pressure kept constant and condenser pressure is change and effect on COP is observed. In third set, mass flow of refrigerant is varied and how that affect refrigerant is observed.

Table 2. Results

Compressor work, kW	Refrigerating effect, kW	COP
31.53	213.1	6.759

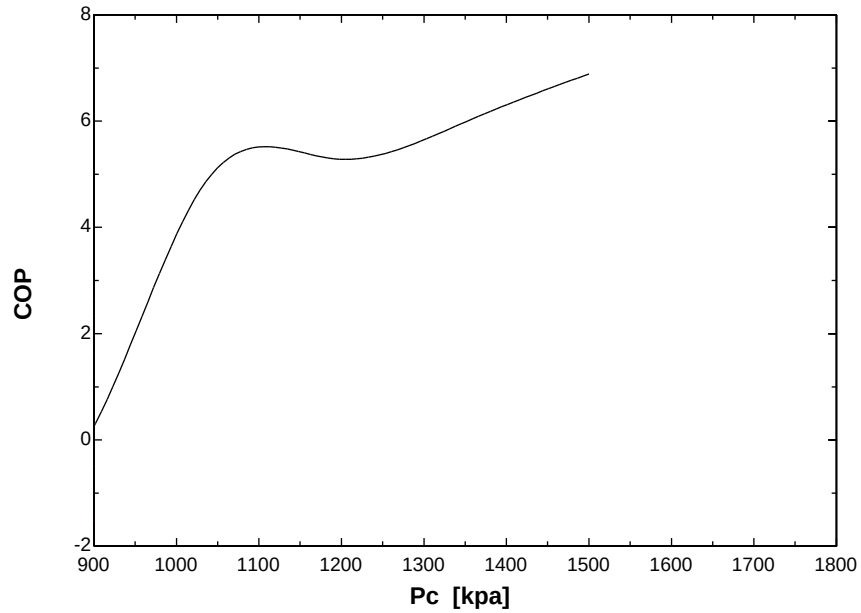

Figure 5. Pc Vs COP

Figure 5 try to explain effect of condenser pressure (Pc) on COP of the system. It can be seen that as Pc increases, Cop of the system increased. For certain range of Pc of around 1100 to 1250 kpa, there is reduction in Cop but beyond that point, COP increases again. But beyond the value of 1650 kpa, Cop falls down drastically. This behavior is observed because for high value of condenser pressure, compressor has to use more electrical work.

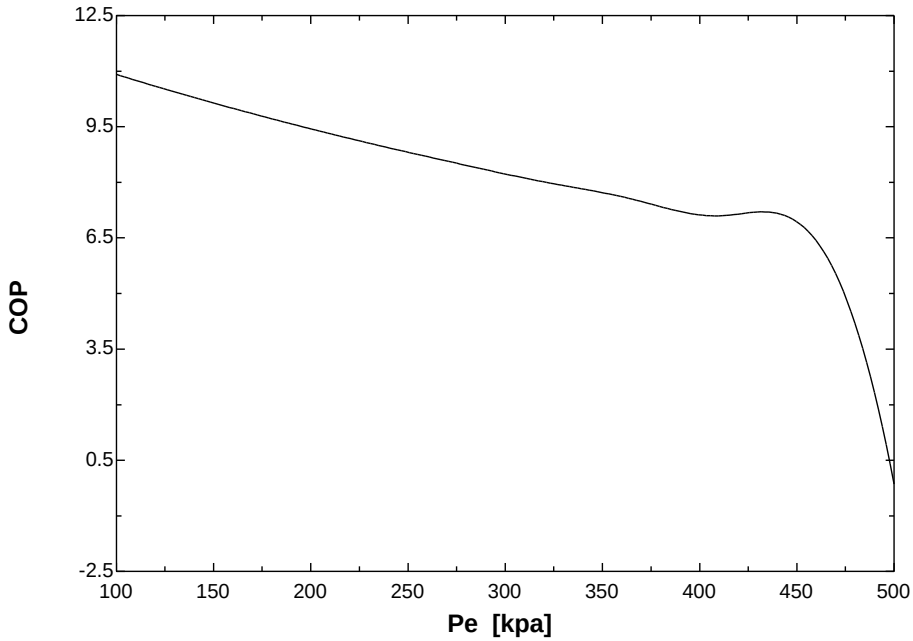

Figure 6. Pe Vs COP

Figure 6 shows the effect of evaporator (Pe) on COP. As its clear that as Pe increases , COP decreases gradually and beyond value of 450, it falls down very rapidly.

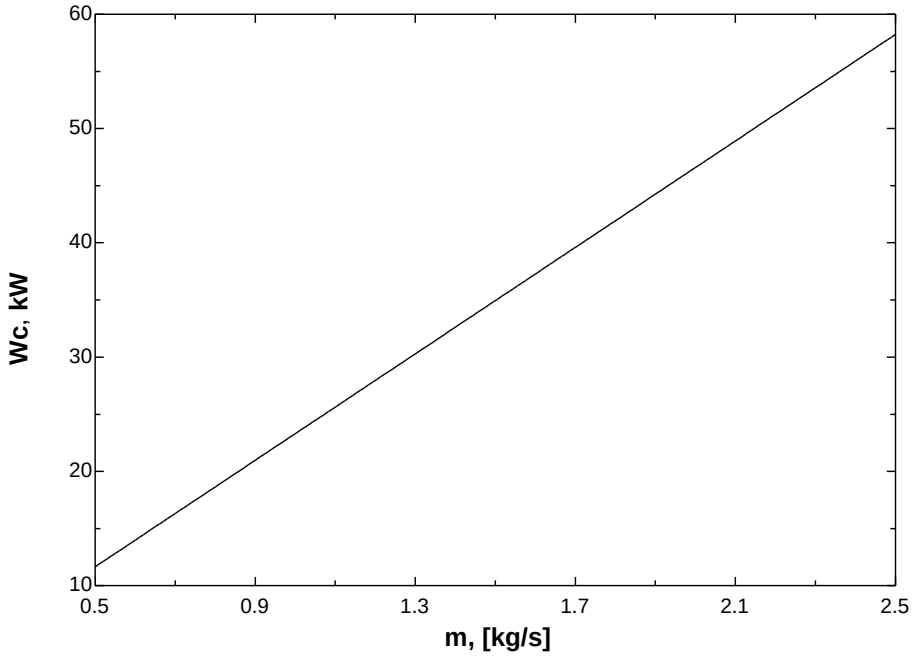

Figure 7, m Vs Wc

Figure 7 explains that as there is increment in mass flow rate of the refrigerant, there is increment in electric power consumed by compressor because it has to work against more amount of refrigerant vapour.

V. CONCLUSION

It is been observed that performance of simple VCR system depends largely upon condenser pressure, evaporator pressure and mass flow rate of refrigerant. If there is variation in these parameters, there is significant variation in performance of the system. For this particular system Pc should be kept in range of 1300 kpa to 1500 kpa and evaporator pressure should kept as low as possible while mass flow rate for refrigerant should kept in range of 1 to 1,5 kg/s.

REFERENCES

[1] Rahul P Patel, Dr. R. G. Kapadia, "Performance Evaluation Of A Vapour Compression Refrigeration System For Simultaneous Cooling And Heating By Using R22 And Alternative Refrigerants", International Journal of Engineering Research & Technology (IJERT) Vol. 2 Issue 4 , pp. 1809-1815, April 2013.
[2] Jianyong Chen, Jianlin Yu, "Performance of a new refrigeration cycle using refrigerant mixture R32/R134a for residential air-conditioner applications" Energy and Buildings 40, pp. 2022–2027, 2008.
[3] B. Hadya, P. Usha Sri and Suresh Akella, "Comparative Study of Eco-friendly Refrigerants in a Lower Capacity Air-Conditioning System" International Conference on Mechanical and Automotive Engineering, pp. 48-51, 2012.
[4] W. Chen, "A comparative study on the performance and environmental characteristics of R410A and R22 residential air conditioners" Applied Thermal Engineering, pp. 28-17, 2008
[5] Liu, Hong "Comparison of energy efficiency between variable refrigerant flow systems and ground source heat pump systems" Energy and Buildings 42, pp. 584–589, 2010
[6] A text book on "Refrigeration and air conditioning" by C P Arora.
[7] A text book on "Refrigeration and air conditioning" by R K Rajput.

