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PERFORMANCE ENHANCEMENT OF VCRS USING LSHX

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Abstract—Vapour compression refrigeration system (VCRS) is used in a small scale to high scale refrigeration system. The VCR system is work on Vapour Compression Cycle (VCC) principle. In this paper we differentiate the VCC in simple and adding Liquid Suction Heat Exchanger (LSHX). By adding heat exchanger in liquid side the temperature of liquid line is higher than the that of the suction line, heat flows the from liquid to suction line and therefore the temperature of exit of condenser is decreases and increase in the suction temperature (superheating). The use of LSHX is always followed by superheating on the suction of the compressor. The superheating causes an increase in the input power. As a result, the use of LSHX is expected to enhance the COP of the system. There are three parameters, viz., the cooling capacity, the discharge temperature and COP investigated in theoretically.

Keywords—Subcooling, Superheating, Heat Exchanger, LSHX, VCRS, COP

I. INTRODUCTION

Refrigeration is a technology which absorbs heat at low temp and provides temperature below the surrounding by rejecting heat to the surrounding at higher temperature. From last 100 years vapour compression system are used and this system is universally accepted for all industrial purposes from a small domestic unit capacity to Cinema-Hall's capacity and it full fill the requirement. Now a days the development in that system is going on which help to increase efficiency of system. On the basis of vapour compression cycle vapour compression refrigeration system work. So this system used in domestic refrigeration, food processing and cold storage, industrial refrigeration system, transport refrigeration and electronic cooling etc. In today's era refrigeration industry is passing through evolutionary changes. Energy saving has become essential key issue not only from the view of energy conservation but also for the global environment. Refrigeration technology is expected to develop technologies which are cheap but most efficient than previous. For improving the performance of system is too important to improve the refrigerating effect or reduce the power consumption of the system.

In nature heat transfer occurs from the region of higher temperature to lower temperature without requiring any external devices. For the transfer of heat from lower temperature to higher temperature we require external work, which help to transfer. Currently in refrigeration & air conditioning stream researcher focuses on improving efficiency, reducing power consumption as well as manufacturing cost of the system & introducing new system having innovative design with compact, functional and user friendly system. These aspects are fulfilled but on their performance as well as on efficiency does not affect.

II. LITERATURE SURVEY

Lokapure and Joshi [1] in their article said that the "the refrigeration heat recovery device is indirect type of system in which a refrigerant to water heat exchanger is installed between the host refrigeration system compressor and condenser." In this case they achieved their goal by recovering energy and improving COP up to 13%. Baskran and Mathews [2] described systems including vapour refrigerants improved by analysing the effect of superheating / subcooling we get better coefficient of performance than non-superheating / subcooling.

Khurmi and Gupta [3] in their book gave evidence that the process of under cooling is also brought about by employing a heat exchanger. This increases refrigerating effect and finally improved coefficient of performance in vapour compression refrigeration system. Prasanna and Kishore [4] has found the COP of the system is increased up to 16% and Mass flow of refrigerant is reduced up to 14% using the heat exchanger with vapour compression refrigeration system. Rajput [5] in his book concluded that sub-cooling results in increase of COP and said that no further energy has to be spent to obtain the extra cold coolant.

Cecep, Martin et. al [6] investigates the use of LSHX in there research paper and concluded that the use of LSHX increases the COP as well as discharged temperature also increases with increase in ambient temperature. Potter and Hrnjak [7] carried out an experimental investigation to study the effect of sub-cooling on various parameters in the air conditioning system using R134a and R1234yf. The experimental results showed that the presence of LSHX in the air conditioner increases the COP up to 18% and 9% for R1234yf and R134a, respectively. The results also showed that there are changes in some parameters due to the presence of sub cooler using LSHX.

III. METHODOLOGY

In nature heat transfer takes place from hot body to cold body without any external sources but if we transfer heat from low body to hot body we require special devices called refrigerator. In refrigerator the phenomenon occurs by using a substances called refrigerant. Vapour compression refrigeration cycle is an improved type of air refrigeration cycle.

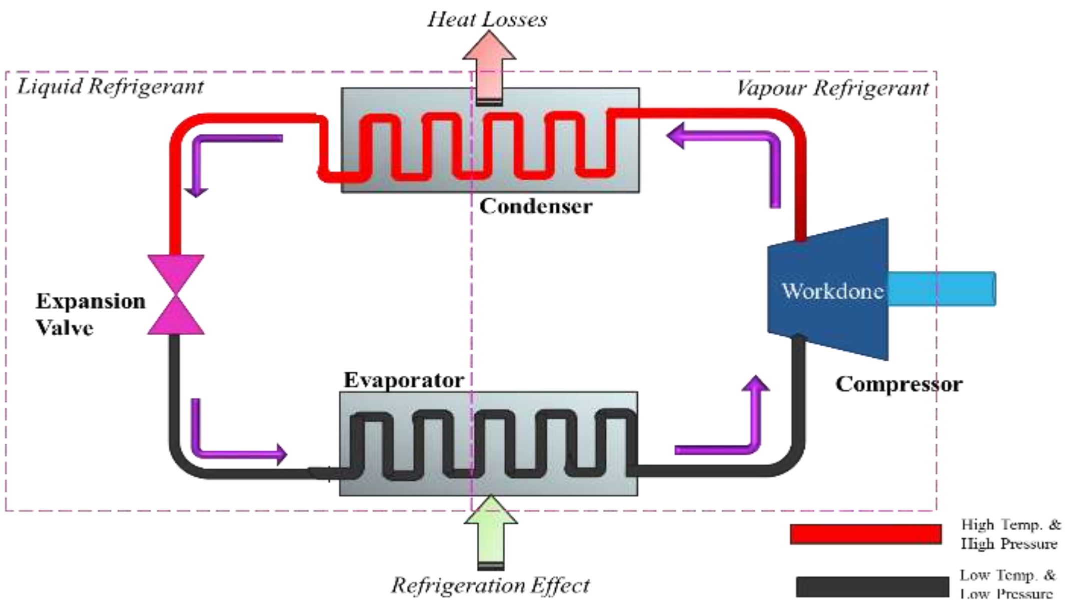

Fig. 1. Schematic diagram of simple VCR System

By using the component Compressor, Condenser, Evaporator and Expansion valve we make a system i.e. vapour compression refrigeration system. R-22 is a substance that help to transfer heat from low body to hot body. The refrigerant (R-22) absorbs heat and hence evaporates at a low pressure to form a gas. This gas is then compressed to a higher pressure, such that it transfers the heat is gained to ambient air or water and turns back (condenses) into a liquid. Thus heat is absorbed, or removed from a low temperature source and transferred to a higher temperature source.

IV. WORKING

Vapour Compression Refrigeration Cycle Processes:

1) Compression Process:

The vapour refrigerant at low temperature & low pressure is compressed isentropically to dry saturated vapour as shown in fig by vertical line on T-S diagram or inclined in P-h diagram. Pressure

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rises from P_1 to P_2 and temperature increases from T_1 to T_2 because a proportion of the energy input into the compression process is transferred to the refrigerant.

2) Condensing Process:

The high pressure and temperature vapour refrigerant from compressor is passed through condenser, where it completely condensed at constant pressure and temperature. The Vapour refrigerant is change into liquid refrigerant. The refrigerant while passing through condenser gives its latent heat to surrounding by condensing medium. After condensation, refrigerant enters the expansion device.

3) Expansion Process:

The high pressure liquid refrigerant passes through expansion valve (device), which both reduces its pressure & temperature and controls the flow into the evaporator.

4) Vaporizing Process:

The liquid vapour mixture of refrigerant at pressure P_4 & T_4 is evaporated and change into vapour refrigerant at constant pressure & temperature during evaporation. During this process it change its state from a liquid to a gas, and at the evaporator exit is slightly superheated. It is again supplied to the compressor. Thus the vapour compression cycle is completed.

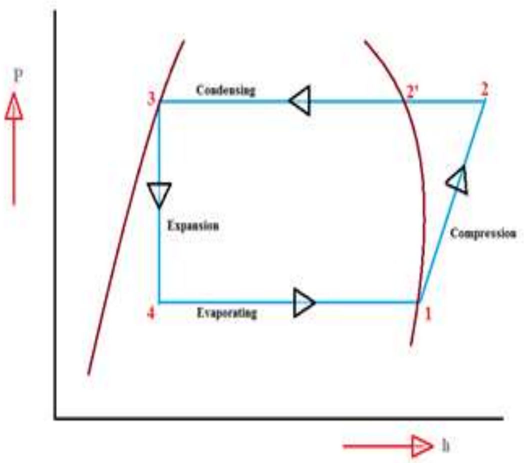

Fig. 2: P-h diagram of VCRS

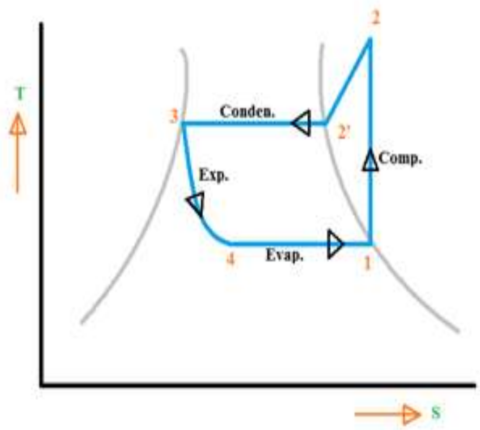

Fig. 3: T-S diagram of VCRS

V. IMPROVING METHOD OF COP

Performance of a simple saturated vapour compression cycle is improved by following methods:

a. By under cooling the liquid refrigerant.
b. Under cooling of liquid refrigerant with the help of refrigerant gas.
c. Under cooling of liquid refrigerant using low temperature liquid refrigerant.
d. Compressing the refrigerant in two stages.

In this paper, using heat exchanger the performance of vapour compression refrigeration system is enhanced. The present study is mostly concentrates on theoretical investigation of the performance of the vapour compression refrigeration cycle.

A) Under cooling of liquid refrigerant with the help of refrigerant gas.

In such case, an additional heat exchanger is provided, where the refrigerant gas saturated temperature is passed from one side and saturated liquid is passed from other side.

A LSHX is a counter flow heat exchanger in which the warm refrigerant liquid from the condenser exchanges heat with the cool refrigerant vapour from the evaporator. Sub cooling is beneficial as it increases the refrigeration effect by reducing the throttling loss at no additional specific work input.

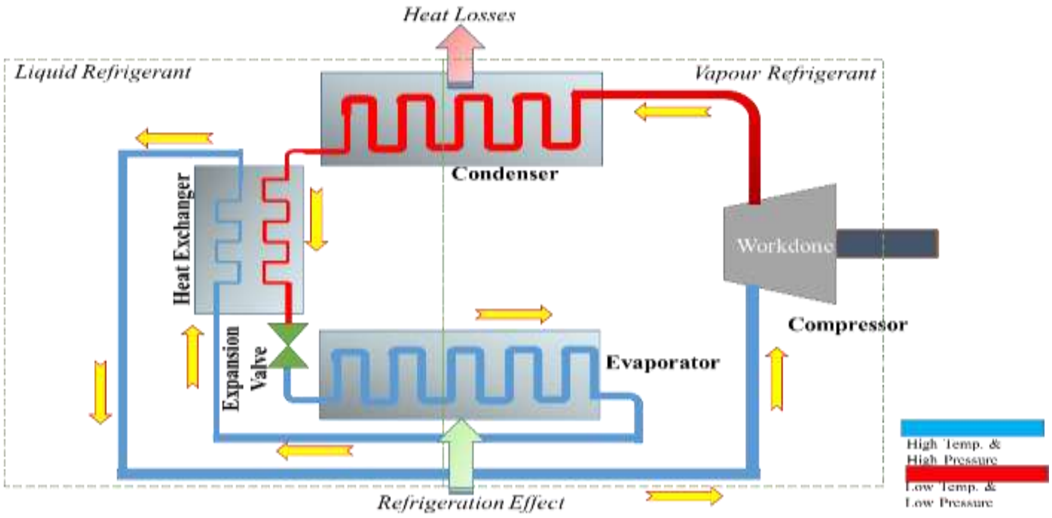

Fig. 4. Schematic diagram of simple VCR System with Heat Exchanger

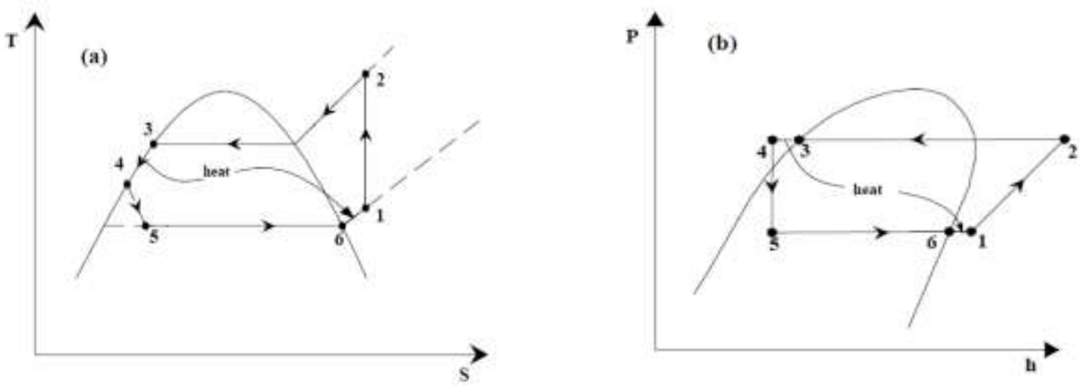

Fig. 5. Single stage Vapour Compression Refrigeration System cycle with LSHX (a) On T-s diagram (b) on P-h diagram

As shown in the T-s diagram, since the temperature of the refrigerant liquid at the exit of condenser is considerably higher than the temperature of refrigerant vapour at the exit of the evaporator, it is possible to sub cool the refrigerant liquid and superheat the refrigerant vapour by exchanging heat between them. Another practical advantage of sub cooling is that there is less vapour at the inlet to the evaporator which leads to lower pressure drop in the evaporator.

The original COP without heat exchanger is,

$$COP_1 = \frac{h_1 - h_4}{h_2 - h_1}$$

And the COP after this heat exchanger becomes,

$$COP_2 = \frac{h_1 - h_5}{h_2 - h_1}$$

VI. RESULTS

The refrigerating effect ($h_1 – h_5$) of the vapour compression cycle after undercooling is higher than the refrigerating effect ($h_1 – h_4$) without undercooling but the compressor work becomes ($h_2 – h_1$), these results enhance the COP of the vapour compression cycle directly and fulfill the our requirement.

VII. CONCLUSION

It is found in practice that this type of undercooling always improves COP and it can be used for low capacity refrigeration as a domestic water cooler & bottle coolers.

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