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Improve C.O.P of Domestic Air conditioner by Modified Cycle

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ABSTRACT: A vapour compression refrigeration system is an improved type of Air refrigeration system. In this the refrigerant mainly use is ammonia, carbon dioxide, sulphur dioxide. In refrigeration the efficiency is measure in terms of COP. Due to this modification, we can gain some output without changing any input parameters & less power will be consumed. So that running cost goes down by doing suitable modifications.

KEYWORDS: Domestic Refrigerator, Modified Cycle, Improve COP

I. INTRODUCTION

As shown in the figure the basic system consists of an evaporator, compressor, condenser and an expansion valve. The refrigeration effect is obtained in the cold region as heat is extracted by the vaporization of refrigerant in the evaporator. The refrigerant vapour from the evaporator is compressed in the compressor to a high pressure at which its saturation temperature is greater than the ambient or any other heat sink. Hence when the high pressure, high temperature refrigerant flows through the condenser, condensation of the vapour into liquid takes place by heat rejection to the heat sink. To complete the cycle, the high pressure liquid is made to flow through an expansion valve. In the expansion valve the pressure and temperature of the refrigerant decrease. This low pressure and low temperature refrigerant vapour evaporates in the evaporator taking heat from the cold region. It should be observed that the system operates on a closed cycle. The system requires input in the form of mechanical work. It extracts heat from a cold space and rejects heat to a high temperature heat sink.

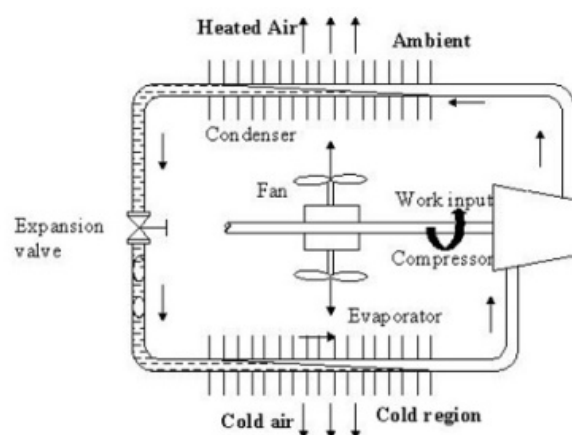


Fig.1-VCRS System

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The refrigerant enters the compressor as a low-temperature gas that has been heated above its boiling point. The compressor pushes the gas out as a very hot vapour. The refrigerant flows to a condenser where the heat is removed by air or water flowing over the condenser coils. As it releases its heat, the refrigerant is cooled below its condensing or "saturation" temperature and becomes a liquid. This is the sub-cooling. The sub cooled high pressure liquid flows to a restriction device, either a capillary tube or thermal expansion valve (TXV). As the liquid flows through the restriction device, it changes from a high-pressure liquid to a low-pressure vapour/liquid mix. This low-pressure mix flows into the evaporator where it absorbs heat above its boiling point. This super-heated gas then flows to the compressor to complete the circuit.

[3] **Akshay Kashyap et al** concluded that coefficient of performance enhancement of a domestic air cooled refrigerator by recovering heat from condenser in terms of its background, originality, current status, and researches. This all work has great significant for developing new technologies relates to heat recovery from a domestic refrigerator, in order to get cooling at low energy cost, no harmful effect to environment and also having low initial cost.

This option is too chip to produce electricity. These sources are permanent and energy is continuously available. There is no pollutions problem with the use of this energy. If we will able to use Non-conventional resources as our expectation lines, we surly solve the entire world crisis gradually.

(a) Important Refrigerant used in VCRS system

Ammonia (NH₃) (R-717) Latent heat = 1312.75 kJ/Kg Specific volume = 0.509 m³/kg

Dichloride-Difluoride methane (Freon-12) (R-12) [C Cl₂ F₂] Latent heat = 162 kJ/Kg Specific volumes = 0.093 m³/kg

Difluoromonochloro methane – or Freon-22 (R-22) [CH Cl F₂] Latent heat = 131 kJ/Kg Specific Volume = 0.15 m³/kg

(b) Methods To Improve C.O.P

1. Cycle with dry saturated vapour after compression
2. Cycle with wet vapour after compression
3. Cycle with superheated vapour after compression
4. Cycle with superheated vapour before compression
5. Cycle with under cooling or sub-cooling of refrigerant

II. RELATED WORK

From the above methods we will adopt anyone method of above mention & accordingly we will measure COP of modified system.[1] **shoyab hussan et al** increased C.O.P of vapor compression refrigerator by decrease in condenser pressure and temperature so the refrigeration effect will increase and compressor input work due to this cop will increase. And also increase in pressure and temperature of evaporator the work input will decrease and refrigeration effect will increase due to this C.O.P will increase.[2] **M. Krishna Prasanna et al** focused on evaporation temperature of heat exchanger.

Others point they were conclude that,

- The refrigeration effect of the system is increased up to 16% using the heat exchanger with vapour Compression refrigeration system.
- The C O P (coefficient of performance) of the system is increased up to 16% using the heat exchanger with vapour compression refrigeration system.
- Mass flow of refrigerant (mR) is reduced up to 14% using the heat exchanger with vapour compression refrigeration system.
- Heat available for desuperheating (Q) increases as the evaporation temperature decreases. So by attaching heat exchanger to the vapour compression refrigeration system and regulating water into heat exchanger, outlet temperature of the water (t₂) in heat exchanger increases. That hot water can be used for useful purpose.
- Power required running the compressor is reduced up to 14% by using the heat exchanger with vapour compression refrigeration system.

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(c) Cycle with under cooling or sub-cooling of refrigerant.

[5] S.Rajavel et al COP of the water cooler increased and the time taken to cool the preferred amount of water reduces. This reduces the consumption of electricity as well. So we are going to work on this direction.

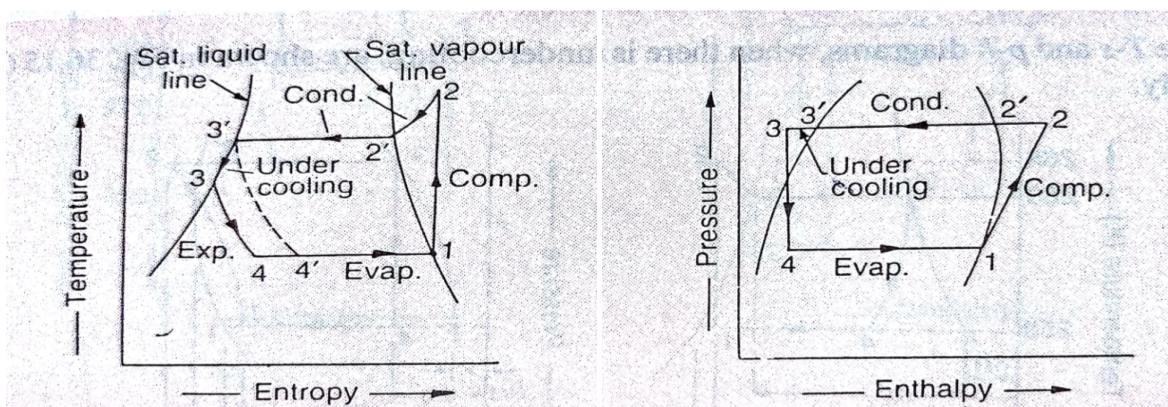


Fig 2 Cycle with under cooling or sub-cooling of refrigeration

Sometimes, the refrigerant, after condensation process 2'-3', is cooled below the saturation temperature (T_3') before expansion by throttling. Such a process called sub-cooling of the refrigerant and is generally done along the liquid line as shown in below figure. The ultimate cooling of the sub-cooling is to increase the value of C.O.P. [4] Shoeb J. Inamdar et al research that Superheating causes variation in the mass flow rate of the gas, if we neglect that variation as it varies to very small extent and can further be minimized by the proper selection of the refrigerant. We can conclude that liquid suction heat exchangers lead to performance improvements for any refrigerant. The compressor power is only slightly affected by the change in state of the refrigerant entering the compressor, which causes the reduction in refrigerant mass flow rate because liquid-suction heat exchangers increase the temperature and reduce the pressure of the refrigerant entering the compressor causing a decrease in the refrigerant density and compressor volumetric efficiency.

III.

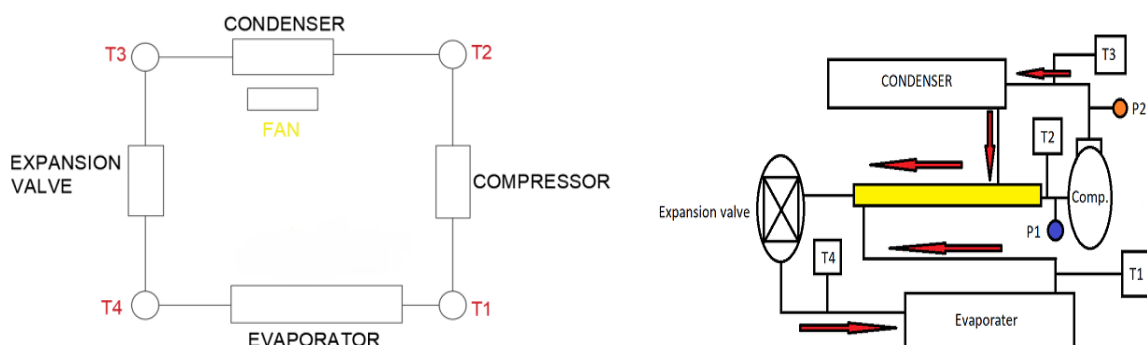


Fig.3 Comparison of simple VCRS and Modified VCRS system

As Shown in fig.3 we modified VCRS system by arranging concentric tube type heat exchanger (as Shown in fig.4) between all four components outlet of condenser, expansion valve, compressor and outlet of evaporator.

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Fig- 4, Developed Concentric tube type Heat exchanger

III. EXPERIMENTAL RESULTS

For the find out C.O.P of cycle we was performed experiments and taking readings. During experiments we taking readings of three different cycles. In which temperature is note down to calculate C.O.P of cycle. T_1 , T_2 , T_3 , T_4 indicates temperature of after evaporator, compressor, condenser and expansion valve respectively. And it was measured by thermocouple.

1. Reading of Simple VCRC Cycle.

Sr. No.	T_1 °C	T_2 °C	T_3 °C	T_4 °C	h_1 (KJ/KG)	h_2 (KJ/KG)	h_3 (KJ/KG)	h_4 (KJ/KG)	C.O.P.
1	31.8	80.6	37.9	23.2	415.1	417.1	416	412.1	1.569
2	29.2	81.1	37.8	21.1	410.9	414.1	414.8	407.1	1.187
3	29.2	93.0	38.6	21.4	410.9	413	416.4	408	1.380
4	30.0	94.1	39.2	20.8	411.0	414	416.9	407.2	1.266
5	30.1	95.0	40.5	22.3	411.0	414	415.2	407.1	1.154
Avg.									1.350

Sample of first reading,
Co-efficient of performance (C.O.P.)

$$= (h_1 - h_4) / (h_2 - h_1)$$

$$= (415.1 - 412.1) / (417.1 - 415.1)$$

$$= 1.569$$

Average C.O.P:- 1.350

In each calculations temperature is measured by thermocouple at specified location and enthalpy value taking from standard table to R-22 refrigerant.

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2. Reading of Modified (water cooling) VCRS System.

Sr. No	T1	T2	T3	T4	h1 (KJ/KG)	h2 (KJ/KG)	h3 (KJ/KG)	h4 (KJ/KG)	C.O.P
1	33.2	42.4	32.9	18	430	526	242	242	1.95
2	31.0	38.3	30.2	25.7	429	525	239	239	1.90
3	31.2	38.85	30.2	25.8	430	526	240	240	1.86
4	31.3	39	30.3	26.1	430	526	240	240	1.89
5	31.2	38.95	30.3	25.9	431	526	240	240	1.85
Avg.									1.89

Sample of first reading,

$$\begin{aligned}\text{Co-efficient of Performance, (C.O.P.)} &= (h1-h4) / (h2 - h1) \\ &= (430 - 242) / (526 - 430) \\ &= 1.95\end{aligned}$$

Average C.O.P:- 1.89

3. Reading of Modified VCRS Cycle

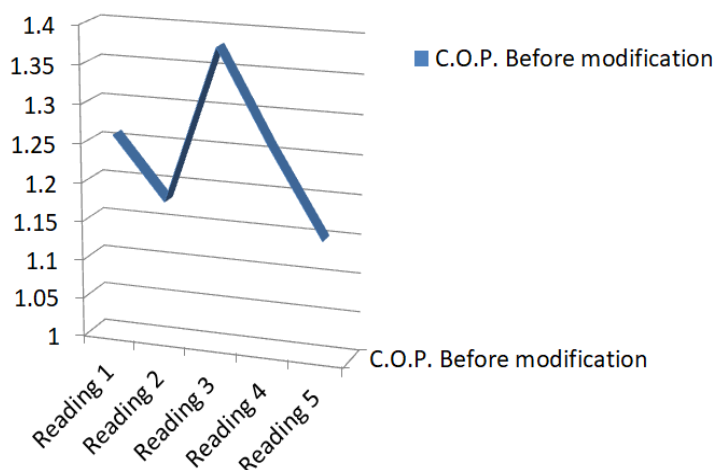
Sr. No	T ₁ ^{°C}	T ₂ ^{°C}	T ₃ ^{°C}	T ₄ ^{°C}	h ₁ (KJ/KG)	h ₂ (KJ/KG)	h ₃ (KJ/KG)	h ₄ (KJ/KG)	C.O.P.
1	20.0	23.5	69	1.2	411.7	412.5	415.5	405.9	1.93
2	19.5	22.0	70.8	3.0	411.5	412.9	415.5	406.1	2.11
3	19.0	24.3	73.6	3.14	411.4	412.8	415.5	406.1	2.03
4	18.5	23.6	74.5	3.85	411.2	412.7	414.9	406.3	2.27
5	18.3	23.3	75.0	3.86	411.0	412.5	414.5	406.5	2.25
Avg.									2.11

Sample of first reading,

$$\begin{aligned}\text{Co-efficient of Performance, (C.O.P.)} &= (h1-h4) / (h2 - h1) \\ &= (411.7 - 405.9) / (412.5 - 411.7) \\ &= 1.93\end{aligned}$$

Average C.O.P:- 2.11

Results of COP



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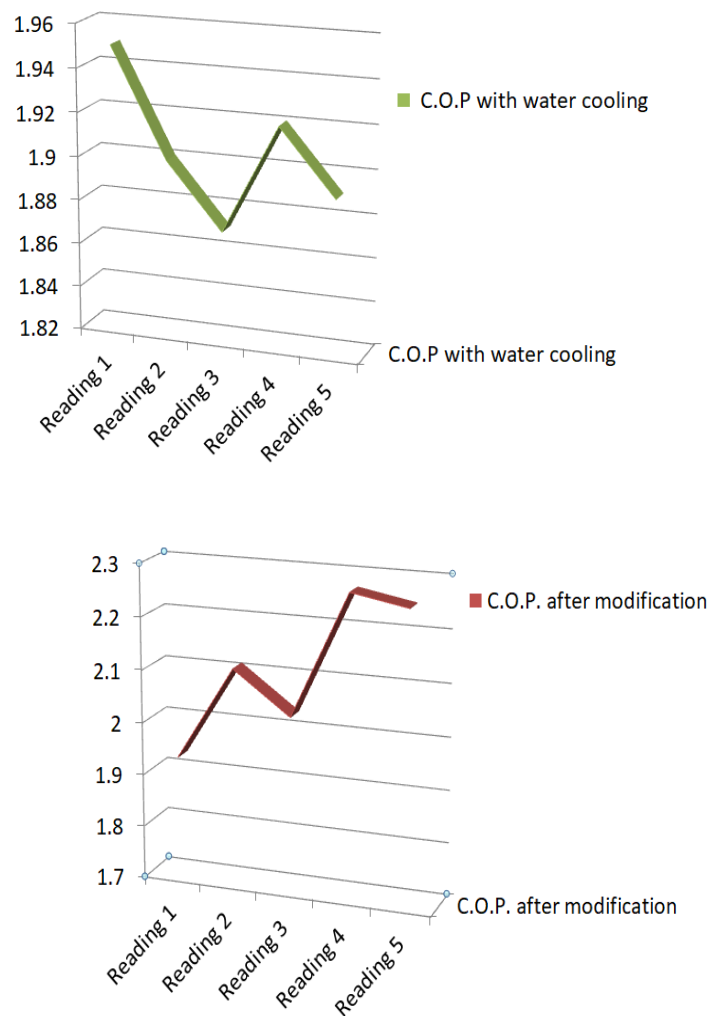


Fig-5, Comparative Graphs of COP with reference to temperature of components of VCRS system

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IV. CONCLUSION

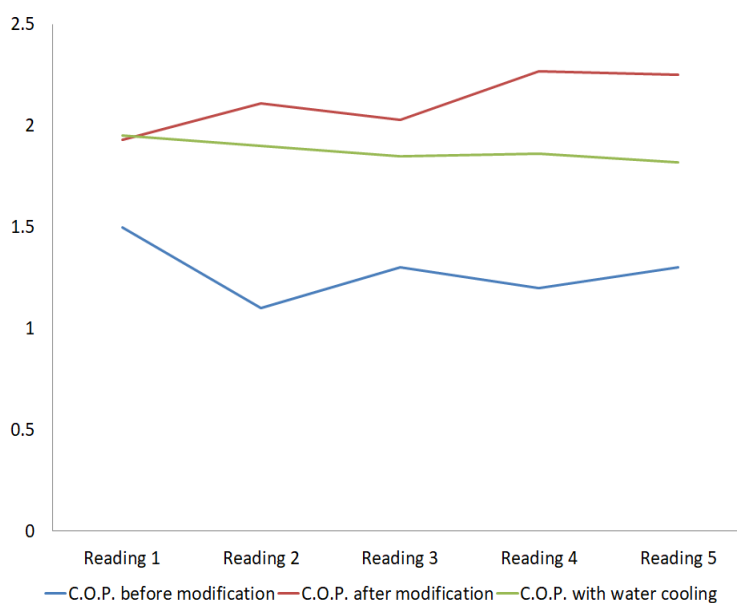


Fig-6, Comparative Results of various C.O.P

As shown in graph indicate that C.O.P of VCRS system due to modified design will increase up to 1 (before modification, existing C.O.P=1.5 and after changes new C.O.P is 2.5)

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Refrigeration and air conditioning
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