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# Experimental Verification of the Variable Affecting the Performance of Vapour Compression Refrigeration Cycle

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***Abstract*** - The performance of heat transfer is one of the most important research areas in the field of thermal engineering. The Refrigeration means a continued extraction of heat from a body whose temperature is lower than the temperature of its surroundings. It also includes the process of decreasing and maintaining the temperature of a body below the general refrigerants, which are used to transfer heat from a low temperature reservoir to high temperature reservoir by using the vapor compression refrigeration temperature of its surroundings. In a Refrigerator, heat is virtually pumped from a lower temperature to a higher temperature. According to Second Law of Thermodynamics, this process can only be performed with the help of some external work. To study the performance of a vapor compression refrigeration system, in this paper work a domestic refrigerator is selected to build the test rig. The literature study has been conducted with two important parameters in order to analyze the performance of the refrigerator; these parameters are pressure and temperature. In this work the performance of refrigeration system is determined using a refrigerant R22 by and evaluated it's Coefficient of Performance (COP).This paper work will help to analyze the difference between actual Coefficient of performance of the domestic refrigerator and its theoretical Coefficient of performance.[1]

***Index Terms -*** *VCRS; COP; Performance; R22*

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## I. Introduction

To study the performance of vapor compression refrigeration system we selected the domestic refrigerating unit to prepare the refrigeration test rig.

Refrigerator consists of hermetic compressors, wire and tube condenser, filter, capillary tube and evaporator coil. Extensive experiments have been conducted to improve the COP of the system. The general opinion at research is to improve the COP of the system; the four components of the system should work at their maximum possible efficiency. In order to improve the COP, experiments have to be conducted for better performance of the components.

To calculate the COP of the refrigerator pressures and temperatures of condenser, evaporator, and expansion valve has to be known. Hence, pressure gauges and temperature indicators have to be placed at certain positions in the system. Test rig is prepared with the necessary arrangements to evaluate the performance.

The first objective of the VCR system is to produce cooling effect, with the simultaneous mode heating and cooling energies can produce using the same electric input at the compressor.[5]

*Refrigeration System*

In other word we can say that it is the closed unit which converts the water in to ice. It is generally used for all industrial purpose from a small refrigerator to a big air conditioning plant.

The main components of Freezer are-
Compressor
Condenser
Chilling chamber (Evaporator)
Expansion device [3]

## II. Main Functions of Parts

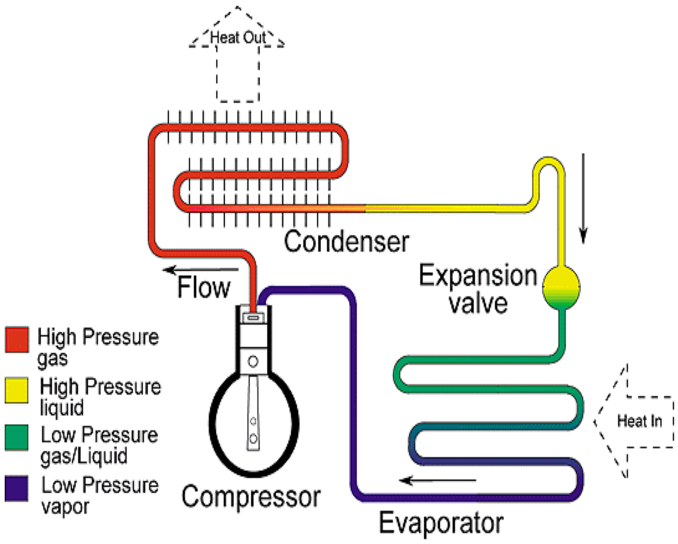


Fig.1 simple vapour compression refrigeration cycle

*A. Compressor*

A refrigerant compressor is a component of a VCRS which functions is to compress the vapour refrigerant which sucked from the evaporator and to raise the pressure so that the corresponding saturation temperature is higher than that of the cooling medium.

According to 2nd law of thermodynamics, the VCRS process can only be performed with the aid of external work which is used for compression of refrigerant. Therefore a compressor must be driven by some prime mover such as electricity.

Another function of a compressor is that it continually circulates the refrigerant through the refrigerating system.

*B. Condenser*

The condenser is an important device which is used to remove heat of the hot vapor refrigerant which discharges from compressor by using cooling medium. This device is used at high pressure side i.e. the portion of the system containing refrigerant under high pressure. The condenser provides required heat transfer surface area where the heat from the hot refrigerant is removed first by transferring it to the walls of condenser tubes (coil) and then from the tubes to the condensing or cooling medium. The selection of a condenser depends upon the capacity of refrigeration system, the type of refrigerant used and the type of cooling medium available.

Fig.2 Air cooled condenser

*C. Evaporator*

The evaporator is a device which is used to provide required heat transfer surface area through which heat is absorbed by the vaporising refrigerant from the cold chamber.

The evaporator is used at low pressure side i.e. the portion of the system where the refrigerant is exerting low pressure.

*D. Expansion device*

The expansion device also known as the metering device or throttling device it is an important device that divides the high pressure side and the low pressure side of refrigerating system. It is connecting between the receivers (containing liquid refrigerant at high pressure) and the evaporator (containing liquid refrigerant at low pressure). Its function is to meter the amount of refrigerant to be supplied to evaporator and to reduce the pressure up to evaporator pressure such that liquid can vaporize in the evaporator coil.

Fig.3 Expansion device (Capillary)

*E. Refrigerant*

The life blood of any refrigerating system is the refrigerant circulating inside the system. It carries heat from the refrigerated space or body to the outside surroundings. A refrigerant is any substance that absorbs heat either by expansion or vaporisation and rejects it through condensation in the condenser. [4]

## III. PERFORMANCE OF STANDARD VAPOUR COMPRESSION CYCLE

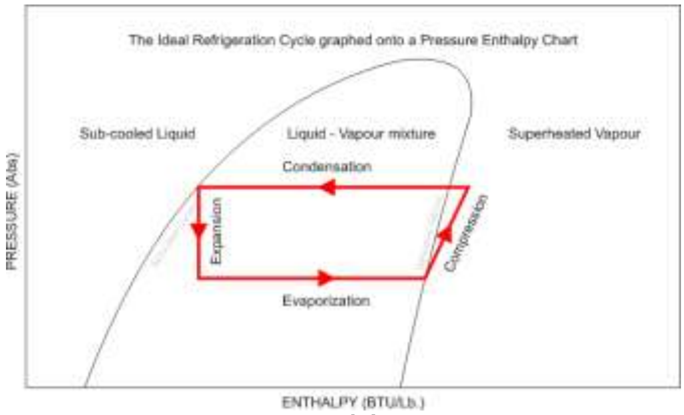


Fig.4 Pressure-Enthalpy Diagrams

Process 1-2 is the compression process wherein Mechanical work is to be supplied (usually in the form of electrical energy) to a compressor. Process 4-1 represents the useful Refrigeration effect. The index of performance is define as coefficient of performance.[2]

Condenser pressure $P_C$=8.84 bar
Evaporator pressure $P_e$=2.04 bar
Condenser temperature $T_C$=35$^0$C
Evaporator temperature $T_e$=-30$^0$C

## From Pressure-Enthalpy diagram for R22[6]

$h_1$=393 KJ/Kg
$h_2$=447 KJ/Kg
$h_3$=$h_4$=242 KJ/Kg

a. Theoretical COP = Useful refrigeration (output) / net work(compressor work)

$$COP\ (theoretical) = (h_1 - h_4)/ (h_2 - h_1) \quad (1)$$
$$=151/54$$
$$=2.79$$

$h_1$ is enthalpy in kJ/kg corresponding to pressure $P_1$ and temperature $T_1$
$h_2$ is enthalpy in kJ/kg corresponding to pressure $P_2$ and temperature $T_2$
$h_3$=h4 is enthalpy in kJ/kg corresponding to pressure $P_2$ and temperature $T_3$

b. Actual COP = Refrigeration effect / Work input

$$COP_{actual} = Q / W$$

$Q = M_w*C_{pw}*(T_f-T_i)/(t*60)$ ……….. (Kw) - (2)
$= 3*4.187*(25-10)/(10*60)$
$= 0.314$ Kw

$W = V*I*Pf$
$= 0.220$ Kw

$COP_{actual} = 0.314/0.220$
$= 1.42$

$T_f$ = Final water temperature placed in evaporator box.
$T_i$ = Initial water temperature placed in evaporator box.

## IV. RESULT

In this work **e**xperiments is conducted by using R22. Here we used a domestic refrigerator and consigned two differential gauges at the evaporator outlet, condenser inlet. In this paper work we have taken the readings by taking the evaporator temperature and noting down the corresponding reading of condenser inlet and outlet, compressor inlet and outlet results are compared by evaluating the COP values. Theoretical Cop value is evaluated by using Ph diagrams of R22 as shown in figure 4 and actual COP value is evaluated by using practical readings.

## V. CONCLUSION

The coefficient of performance of domestic refrigeration is obtained as 2.79 by theoretically using R22 as a refrigerant and the coefficient of performance by actually 1.42. The actual COP is less than the theoretical due to losses at different points and also error made while measurement of pressure and temperature.

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