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EXPERIMENTAL INVESTIGATION ON PERFORMANCE OF VAPOUR COMPRESSION REFRIGERATION SYSTEM BY ARRANGING THE NOZZLE AT THE OUTLET OF CONDENSER

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Abstract

Vapour compression refrigeration system is a high dimensional thermodynamic coupling system in which the coefficient of performance (COP) is the area of interest and tremendous researches are going to increase the coefficient of performance (COP). In this work a Vapour compression refrigeration system using R134a refrigerant as a working fluid and working based on a vapour compression cycle is designed and fabricated. In this system nozzle is placed between the high pressure side (condenser) and low pressure side (expansion valve). The main aim of this study is to find the effect of nozzle arrangement on COP of a system. The nozzle placed is used to increase the velocity of refrigerant liquid going from condenser to expansion valve. An experimental investigation has been performed on this system with concentrating variables like coefficient of performance (COP), compressor power consumption and cooling capacity. The COP of a system is increased after placing the nozzle between condenser and expansion valve.

Keywords: Nozzle , VCR System and Coefficient of performance(COP)

1.**Introduction**

Refrigeration is the science of the producing and maintaining temperatures below that of the surrounding atmosphere. This means the removing of heat from a substance to be cooled. Heat always passes downhill, from a warm body to a cooler one, until both bodies are at the same temperature. Not only perishables today many human work spaces in offices and factory buildings are air-conditioned and a refrigeration unit is the heart of the system. Before the advent of mechanical refrigeration water was kept cool by storing it in semiporous jugs so that the water could seep through and evaporate. The evaporation carried away heat and cooled the water. This system was used by the Egyptians and by Indians in the Southwest. Natural ice from lakes and rivers was often cut during winter and stored in caves, straw-lined pits, and later in sawdust insulated buildings to be used as required.

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The Romans carried pack trains of snow from Alps to Rome for cooling the emperor's drinks. Though these methods of cooling all make use of natural phenomena, they were used to maintain a lower temperature in a space or product and may properly be called refrigeration. In simple, refrigeration means the cooling or removal of heat from a system. The equipment employed to maintain the system at a low temperature is termed as refrigerating system and the system which is kept at lower temperature is called refrigerated system.

Refrigeration is generally produced in one on the following three ways:

(1) By melting of a solid,
(2) By sublimation of a solid, and
(3) By evaporation of a liquid.

Most of the commercial refrigeration is produced by the evaporation of a liquid called refrigerant Mechanical refrigeration depends upon the evaporation of liquid refrigerant and its circuit includes the equipment's naming evaporator, compressor, condenser and expansion valve. It is used for preservation of food, manufacture of ice, solid carbon-dioxide and control of air temperature and humidity in the air-conditioning system.

All refrigeration systems must include at least four basic units as given below:

•A low temperature thermal "sink" to which heat will flow from the space to be cooled.

•Means of extracting energy from the sink, raising the temperature level of this energy, and delivering it to a heat receiver.

•A receiver to which heat will be transferred from the high temperature high pressure refrigerant.

•Means of reducing pressure and temperature of the refrigerant as it returns from the receiver to the "sink".

G. Naga Raju et al., [1] the coefficient of performance (COP) of vapour compression refrigeration system is enhanced by using the diffuser at compressor inlet and as well as condenser inlet. When using the diffuser at compressor inlet the coefficient of performance is increased by 6% and using the diffuser at condenser inlet the coefficient of performance is increased by 3%. Neeraj Upadhyay et al., [2] the analytical study of vapour compression refrigeration system using diffuser and sub-cooling is made. This is to improve the cop of the system either by decreasing the compressor work or by increasing the refrigeration effect. In this word refrigeration effect is increased by incorporating sub coo1ing process and by using the diffuser power consumption to compressor is reduced and cop is enhanced from 2.65 to 3.38.

Vivek Kumar et al., [3] a vapour compression refrigeration system configuration is made by inducting one diffuser in between the condenser inlet and compressor and other one is in between expansion valve and condenser outlet. By victimization these two the various parameters like coefficient of performance, refrigerant impact and compressor work of this system are calculated with the help of R134a refrigerant. By comparing these parameters with convectional system the cop of changed system is observed to be increased by around 1.14. Nurul Serajl et al, [4] the increase in the coefficient of performance of vapour compression refrigeration system using diffuser of increasing Cross-sectional area is designed, invented and studied. The dimension of diffuser that is selected was of 15 Degree divergence ang1e. By using diffuser the power consumption reduces to smaller amount for same refrigeration effect and therefore work input is decreased. Also the size of the condenser can even be reduced because of additional heat transfer which leads to increase the coefficient of performance (COP).

2. Methodology

In the vapour compression refrigeration system, the refrigerant always undergoes the phase change from liquid to vapour and then vapour to liquid during a closed cycle by absorbing the heat or warmth from the products to be refrigerated within the evaporator and reject the heat or warmth at condenser. The coefficient of performance (cop), that may be a magnitude reaction of

heat transfer rate at the evaporator to the ability input to the compressor within the refrigeration system. The COP will be increased either by decreasing the compressor work or by increasing the refrigeration effect. Completely different ways form nozzle ii) Without using nozzle .

are tried for improving the cop of the VCR system, as according to literature a setup was fabricated by placing a nozzle in between condenser outlet and expansion valve and performance was measured in two cases: i) when the passage of refrigerant

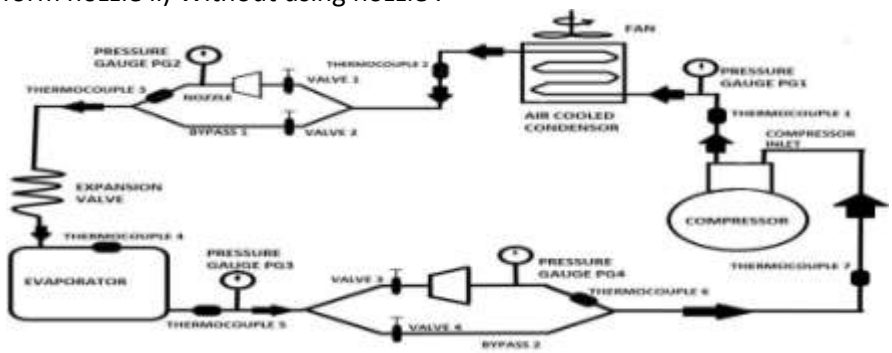

Fig. 1 Layout of Experimental Setup

Nozzle

A nozzle is often a pipe or tube of varying cross sectional area and it can be used to direct or modify the flow of a fluid (liquid or gas). Nozzles are frequently used to control the rate of flow, speed, direction, mass, shape, and/or the pressure of the stream that emerges from them. In a nozzle, the velocity of fluid increases at the expense of its pressure energy.

Fig.2: Nozzle for the experiment

SHUT OFF VALVE:

Shut off valves allow for the safe control of compressed air in pneumatic applications and are used in a range of industries. Shut off valves are also a useful accessory to stop the air supply in controlled conditions where a process must work correctly and safely. They are used to control the flow of refrigerant used in the circuit.

Fig. 3: Flow shut off valve

3. Working

The setup is made to work as a comparison system between various configurations. We can create various configurations according to the valve openings and they are as follows

- Valve 1 And Valve 4 Open – VCR With Nozzle
- Valve 2 And Valve 4 Open – Simple VCR Circuit The main working is as follows
- The refrigerant enters the compressor at low temperature and low pressure. It is in a gaseous state. Here, compression takes place to raise the temperature and refrigerant pressure. The refrigerant leaves the compressor and enters to the condenser.
- The vapor travels through part of the condenser which removes the superheat by cooling the vapor with constant pressure
- The saturated liquid refrigerant passes through the expansion valve and undergoes an abrupt decrease of pressure. That process results in the adiabatic flash evaporation and auto-refrigeration of a portion of the liquid, the adiabatic flash evaporation process is isenthalpic.
- The cold and partially vaporized refrigerant travels through the coil or tubes in the evaporator where it is totally vaporized by the warm air (from the space being refrigerated) that a fan circulates across the coil or tubes in the evaporator. The evaporator operates at essentially constant pressure and boils off all available liquid vapour.

The required circuit is obtained by using the given valve configurations. Then the compressor is supplied.

4. Results and Discussions

Experiments are performed with and without passage of refrigerant form nozzle and results are calculated by substituting the experimental observations in suitable formulae.

The experimental observations and results are tabulated below.

S. No	Condition	Work Input(kW)	Refrigeration Effect (kW)	COP
1	Simple VCR	0.18	0.45	2.5
2	VCR With Nozzle	0.18	0.47	2.61

Table 1: Experimental results

The results shows that the coefficient of performance is increased by placing of nozzle before the expansion valve is due to reduction of temperature before the expansion can increase the performance of VCR system and for the same amount of heat input the refrigeration effect also increased.

5.Conclusion

Experimental investigation on performance of VCR cycle is analyzed. This experimental data was used to analyze the performance of vapour compression refrigeration system with and without the nozzle. The present work is observed that a nozzle at the outlet of the condenser, this gives the following results, by maintaining constant pressures.

1) Power consumption can be reduced by 6.7%
2) COP Of the system increased from 2.5 to 2.61.

It can be said that it is more useful to provide a nozzle at the outlet of the condenser and maintain the condenser pressure from the present work. The performance of vapour compression refrigeration system can be enhanced with the help of the nozzle at the out let of condenser.

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