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

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Abstract

A high-dimensional thermodynamic coupling system, a vapour compression refrigeration system's coefficient of performance (COP) is of primary importance, and much research is planned to enhance the COP. Here, we develop and build a vapour compression refrigeration system that uses the R134a refrigerant and operates on the principle of a vapour compression cycle. A nozzle is positioned between the expansion valve and the high-pressure side of the system, which is the condenser. Determining how nozzle configuration affects COP is the primary objective of this research. The purpose of the nozzle is to accelerate the flow of the refrigerant liquid from the condenser to the expansion valve. Concentrating factors such as cooling capacity, compressor power consumption, and coefficient of performance (COP) were the focus of an experimental examination on this system. Adding a nozzle to a system and positioning it between the condenser and expansion valve increases the COP.

Keywords:*Nozzle,VCRSystemandCoefficientofperformance(COP)*

Introduction

Producing and sustaining temperatures lower than those of the surrounding atmosphere is the domain of refrigeration. This is the process of cooling something by drawing out its heat. As long as two bodies are not at different temperatures, heat will always be transferred from one to the other. A refrigeration unit is the brains of an air conditioning system, which not only cools perishable goods but also numerous human work areas in modern office and industrial buildings. Semiporous jugs allowed water to soak through and evaporate, keeping the water cold before artificial refrigeration. Water was cooled by evaporation, which removed heat. The Southwest Indians and the Egyptians both employed this approach. Caverns, pits lined with straw, and eventually sawdust-insulated structures were common places to store naturally occurring ice from rivers and lakes for usage during the winter. Pack trains of snow were brought to Rome from the Alps by the Romans to chill the emperor's beverages. Although all of these cooling techniques rely on natural events, refrigeration is the more accurate term for what they did: they kept a room or product at a lower temperature. Cooling down or removing heat from a system is what refrigeration is all about, in a nutshell. The system that is maintained at a lower temperature is called a refrigerated system, and the equipment that is used to do so is called a refrigerating system. The three main methods for making refrigeration are:

(1) When a solid melts, (2) When a solid sublimates, and

Thirdly, when a liquid evaporates. The process of refrigerant evaporation is the main one used in commercial refrigeration. The four main pieces of machinery that make up a mechanical refrigeration system—the evaporator, compressor, condenser, and expansion valve—are all dependent on the evaporation of liquid refrigerant. Use it to make ice, solid carbon dioxide, and regulate the humidity and temperature of the air in your air conditioner, among other things. As shown below, all refrigeration systems are required to include the following four components:
Here we have a low-temperature thermal "sink" that will receive heat from the area that needs cooling.
• Methods for accumulating heat from a washbasin, transferring it to a heat receiver, and then increasing its temperature. The high-pressure, high-temperature refrigerant will be transmitted to a receiver. Reducing the pressure and temperature of the refrigerant as it flows backwards from the receiver to the "sink" describes one method.
Diffusers placed at the compressor and condenser inlets improve the vapour compression refrigeration system's coefficient of performance (COP), according to G. Naga Raju et al., [1]. using the diffuser at the compressor intake boosts the performance coefficient by 6%, while using it at the condenser inlet boosts it by 3%. An analytical research was conducted by Neeraj Upadhyay et al., [2] on a vapour compression refrigeration system that makes use of a diffuser and sub-cooling. This will enhance the system's cop by boosting the refrigeration impact or minimising the compressor effort. Incorporating the subcooling process and making use of the diffuser both boost the cooling effect while decreasing the compressor's power consumption and improving the coefficient of performance (COP) from 2.65 to 3.38.
In a vapour compression refrigeration system arrangement, according to Vivek Kumar et al. [3], two diffusers are inserted: one between the compressor and condenser intake, and the other between the expansion valve and condenser output. These two methods are used to compute the many characteristics of this system using R134a refrigerant, such as the coefficient of performance, the influence of the refrigerant, and the work done by the compressor. When these parameters are compared to the convectional system, it is shown that the cop of the modified system is enhanced by around 1.14. The authors Nurul Serajl et al. [4] investigated, created, and constructed a diffuser with an increasing cross-sectional area to raise the performance coefficient of a vapour compression refrigeration system. A 15-degree divergence angle was chosen for the diffuser's dimensions. The use of a diffuser lowers the power consumption and, by extension, the labour input required to provide the same cooling effect as a larger refrigeration system. Because of the greater heat transfer that increases the coefficient of performance (COP), the size of the condenser may be lowered as well.

1. Methodology

As it absorbs heat from the products to be cooled in the evaporator and rejects it at the condenser, the refrigerant in a vapour compression refrigeration system constantly goes through a closed cycle of changing phases from liquid to vapour and back to liquid. A refrigeration system's coefficient of performance (cop), which is a magnitude response of the evaporator's heat transfer rate to the compressor's ability input. Either boosting the cooling effect or minimising the compressor effort will raise the COP. Various approaches have been taken to enhance the VCR system's cop. One method involved fabricating a setup with a nozzle sandwiched between the condenser outlet and expansion valve. Performance was then measured in two scenarios: i) with the nozzle in place and ii) without.

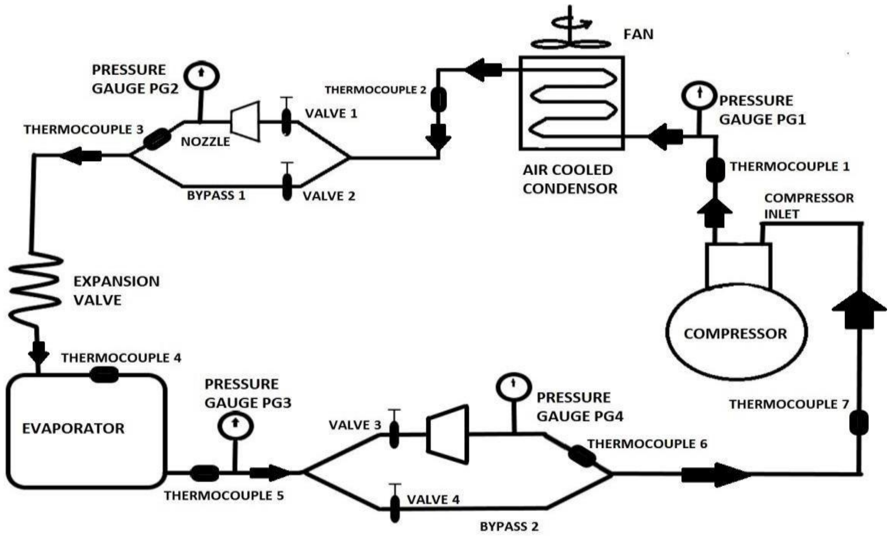

Fig.1LayoutofExperimentalSetup

1.1 Nozzle

Anozzleisoftenapipeortubeof varyingcrosssectionalareaanditcanbe usedtodirectormodifytheflowofafluid (liquidorgas).Nozzlesarefrequently usedtocontroltherateofflow,speed,direction,mass,shape,and/orthepressureof the stream that emerges from them. In a nozzle, the velocity of fluid increases at the expense of its pressure energy.

Fig.2:Nozzlefortheexperiment

1.2 SHUTOFFVALVE:

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 correctlyandsafely.Theyareusedtocontroltheflowofrefrigerantusedinthe circuit.

Fig.3:Flowshutoffvalve

2. Working

It is designed to function as a method for comparing different setups. The following are some of the many configurations that may be achieved by adjusting the valve openings: · A VCR with a nozzle operates with valves 1 and 4 open. • A simple VCR circuit operates with valves 2 and 4. Here is the basic operation:

• Low-pressure and low-temperature refrigerant enters the compressor. At the moment, it is a gas. Compression is used here to increase the pressure and temperature of the refrigerant. The condenser is where the refrigerant goes when it exits the compressor. A portion of the condenser is used to cool the vapour at a steady pressure, so removing the superheat.

• The expansion valve causes the pressure of the saturated liquid refrigerant to drop suddenly. A part of the liquid undergoes auto-refrigeration as a consequence of the adiabatic flash evaporation process, which is an isenthalpic reaction.

• The fan-circulated heated air from the conditioned room is forced through the evaporator's coils and tubes, completely vaporising the cold and partly vaporised refrigerant. At a pressure that is almost constant, the evaporator boils out any liquid vapour that is present. Applying the specified valve designs yields the necessary circuit. After that, the compressor is delivered.

3. ResultsandDiscussions

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

Theexperimentalobservationsandresultsaretabulatedbelow.

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

Table1:Experimentalresults

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.

4. Conclusion

The results of an experimental study on the efficiency of the VCR cycle are reviewed. Using these experimental results, we compared the efficiency of the nozzle-less and nozzle-within vapour compression refrigeration systems. In this study, we found that by placing a nozzle at the condenser's exit, we could keep the pressures constant and get the following findings.

(1) A 6.7% decrease in power usage is possible.

2) The system's COP went raised from 2.5 to 2.61.

Keeping the condenser pressure constant and installing a nozzle at the condenser's outflow would be considered more practical. Adding a nozzle to the condenser's outlet improves the efficiency of a vapour compression refrigeration system.

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