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Experimental Investigation of VCRS with Diffuser at Condenser

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Abstract

This workrepresents the concept of effect of diffuser in vapour compression system on the Coefficient of Performance ofVapourCompression refrigerationsystem mainly carried out to enhance the coefficient of performance of system.It is essential to enhance the coefficient of performance, it is required that compressor work should decrease and refrigerating effect should increase. The aim of a compressor in vapor compression system is to elevate the pressure of the refrigerant, but refrigerant leaves the compressor with comparatively high velocity which may cause splashing of liquid refrigerant in the condenser, liquid hump and damage to condenser by erosion. It is needed to convert this kinetic energy to pressure energy for this purpose diffuser can be used. By using diffuserin vapour compression system, power required for compressor is less for same refrigerating effect so performance is improved. The size of the condenser can also be reduced due to more heat transfer, by using diffuser coefficient of performance improved by22.21%.
Keywords:*Diffuser, Compressor, Condenser.*

1. Introduction

Refrigeration is the process of removing heat from an enclosed space or from a substance in order to lower the temperature below the surrounding temperature, wherein the cooling medium, or refrigerant, goes through a cycle so that it can be recovered for reuse. The commonly used refrigeration systems are vapour-compression. The Vapour Compression Refrigeration Cycle is a process that cools an enclosed space to a temperature lower than the surroundings. To accomplish this, heat must be removed from the enclosed space and dissipated into the surroundings. During the cycle, a substance called the refrigerant circulates continuously through four stages.[1]
In this work, diffuser is installed at condenser inlet. In vapour compression refrigeration system, condenser is used to remove heat from high pressure vapour refrigerant and converts it into high pressure liquid refrigerant. The refrigerant flows inside the coils of condenser and cooling fluid flows over the condenser coils. Condenser used in domestic vapour compression refrigeration system is air cooled condenser, which may be naturally or forced aircooled. Heat transfer occurs from the refrigerant to the cooling fluid. High pressure liquid refrigerant flows through an expansion device to obtain low pressure refrigerant. Low pressure refrigerant flows through the evaporator. Liquid refrigerant in the evaporator absorbs latent heat and get converted into vapour refrigerant which returns to compressor. In the present cycle, the vapor refrigerantleaves the compressor with comparatively high velocity. This high velocity refrigerant directly impinges on the tubing of condenser which may cause damage to it by vibration, pitting or erosion. It results in undesirable splashing of refrigerant in the condenser coil. It also results a phenomenon called as "liquid hump". Liquid hump refers to a rise in the level of the condensed refrigerant liquid in the central portion of the condenser as compared to the level at the ends of the condenser.
The cross-sectional area of diffuser should reduce in the flow direction for supersonic flows and should increase for subsonic flows [8]. The velocity of refrigerant leaving the compressor is sub-sonic. Hence, crosssectional
area of diffuser should be increasing.

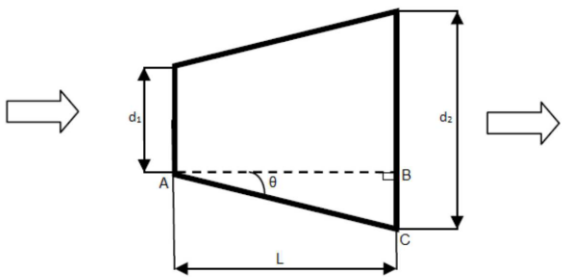

Fig.1 Geometry of diffuser
Diffuser's inlet and outlet diameters were designed. To design length of diffuser equation is developed from Figure.
$L=AB= [(d_2-d_1)/2]/ \tan\theta$

2. Methodology

In vapour compression refrigeration system with diffuser at condenser inlet is shown in figure 3. The system consists of two flow lines one is simple VCRS flow line without diffuser and other is flow line with diffuser. Two pressure gauges are installed at diffuser outlet and at simple flow line to measure the pressure

of the refrigerant at diffuser outlet and pressure in simple VCRS flow line. In this work need to calculate the pressure with and without diffuser. A fan is introduced to condenser for the subcooling effect. The both lines can be opened or closed with the help of flow control valves. A constant refrigeration effect is maintained throughout the experiment. The experiment is performed by taking readings with and without diffuser and compared with each other.

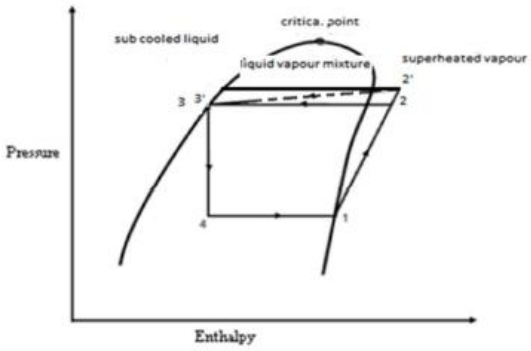

Fig.2 Pressure-Enthalpy chart

Fig.3 Diffuser

Fig.4 Experimental Setup

Figure 2 shows the pressure enthalpy chart of the system. The path 1-2-3-4 shows the VCR cycle without diffuser
and path 1-2'-3'-4 shows the VCR cycle with diffuser at condenser inlet.

2.1 Observation Table

a) Without Diffuser

Sr. No	Refrigerent Temperatures (°C)				Water Temp. (°C)	Refrigerent Pressure (Psi)		EMR (KW hr)
	T1	T2	T3	T4	Tw	Ps	Pd	
01	28	36	34	28	26	18	240	1.10
02	26	60	38	30	22	24	300	1.20
03	28	63	39	32	20	26	305	1.25
04	25	65	40	30	16	28	322	1.30
05	24	66	40	31	14	30	330	1.35

b.With Diffuser

Sr. No	Refrigerent Temperatures (°C)				Water Temp. (°C)	Refrigerent Pressure (Psi)		EMR (KW hr)
	T1	T2	T3	T4	Tw	Ps	Pd	
01	29	36	34	29	26	19	240	1.10
02	28	60	38	32	22	26	300	1.20
03	28	63	39	32	20	27	305	1.25
04	25	65	40	30	16	29	322	1.30
05	26	66	40	33	14	32	330	1.30

3. Result and Discussions

Parameters	Without Diffuser			With Diffuser		
	RE (KW)	Wc (KW)	COP	RE (KW)	Wc (KW)	COP
R-134a	752.4	902	0.8343	752.4	720	1.045

Conclusions

From this research work it is concluded that

1.By using diffuser Coefficient of Performance increased by 22.21%.

2. Due to diffuser Compressor work decreased by 20.18%

3. The heat transfer will increase due to increase in pressure and temperature so the enhancement occurs in coefficient of Performance of the system.

4. By using diffuser in vapour compression system, power required for compressor is less for same refrigerating effect.

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