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Enhancement of Cop of Vapour Compression Refrigeration System by using Diffuser

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Abstract - This experimental investigation exemplifies the design and testing of four diffusers at compressor inlet and condenser inlet in the vapour compression refrigeration system with the help of R134a refrigerant .The Four diffusers with divergence angle of 10°,12°, 14° are designed for same inlet and outlet diameters. Diffusers are testing at compressor inlet first.

The diffusers are used with inlet diameter equal to discharging tube diameter of evaporator and outlet diameter is equal to suction tube diameter of the compressor. One of the diffuser gives the better performance, it will fixed at compressor inlet. Then diffusers are testing at condenser inlet, diffuser inlet diameter equal to discharging tube diameter of compressor and outlet diameter equal to condenser inlet diameter The system is analyzes using the first and second laws of thermodynamics, to determine the refrigerating effect, the compressor work input, coefficient of performance(COP). During the experimental test,the coefficient of performance (COP) of the system without diffuser and with diffuser optimized at compressor inlet and condenser inlet are find out. At compressor inlet 14° divergence angle of diffuser given the maximum cop (2.46).

Percentage of increase in cop is approximately 6%. At condenser inlet 12° divergence angle of diffuser given the maximum cop (2.59).Percentage of increase in cop is approximately 3%.

Index Terms: Diffuser, Refrigeration effect, Compressor work, coefficient of performance, Diffuser work.

I.INTRODUCTION

The coefficient of performance, it is to require either increasing the refrigeration effect or decreasing the compressor work.

In this analysis by using diffuser power consumption is less for same refrigerating effect so performance is improved. In this experiment design of diffuser is very important. To design the diffuser of increasing cross-section area profile with 15 degrees divergence angle. The cop increased by 9.009% in refrigeration system when diffuser is introduced at condenser inlet.

We have developed a new configuration by inducting

1. Diffuser in between the condenser inlet and compressor
2. Heat exchanger at condenser outlet. By using these two to evaluate the different parameters like coefficient of performance, refrigerating effect and compressor work of this system with the help of R134a refrigerant. Compared these parameters with convectional system the cop of modified system increased by approximately 1.14.

To developed a new configuration of the ejector-vapour compression refrigeration cycle, which used an internal heat exchanger and intercooler to enhance the overall performance of the refrigeration cycle. On the basis of first and second laws of thermodynamics theoretical analysis on the overall performance characteristics was find out. The results of the evaporative and condenser temperatures on the coefficient of performance, 2nd law efficiency, exergy destruction rate and entrainment ratio had been investigated. The results obtained showed that there were increases of 8.6% and 8.15% in coefficient of performance and second law efficiency values respectively of this new ejector-vapour compression refrigeration cycle compared to the conventional ejector-vapour compression refrigeration cycle with R125. It was also determined that there has been increase of 21% in the coefficient of performance of the new ejector-vapour compression cycle compared to the traditional vapour compression refrigeration cycle.

We have studied the performance of different condenser by changing the pressure and change in cop of refrigeration system. When changing the convectional condenser by micro channel heat exchanger the pressure changes there are change in rate of heat transfer. This will helps to control the heat losses occurring in the condenser section. So that system of different condenser is gives the batter cop than the convectional system.

In this paper carried the experimental investigation on refrigeration system by using the nozzle at evaporator inlet. Nozzle is a device, it converts the pressure energy into kinetic energy without any input. This concept to reduce the flooding effect on the compressor during the no load conditions and increases the coefficient of performance the system. With the help of nozzle only vapor refrigerant will enter into the compressor and protect it from damages.

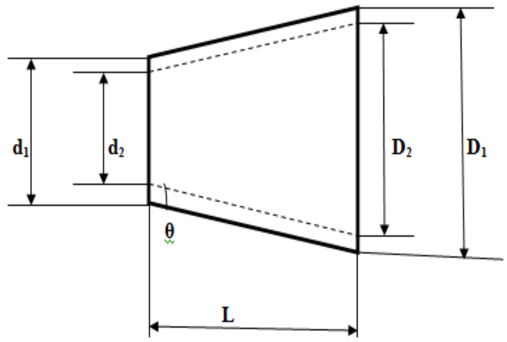
II. METHOLOGY

Manufacturing of diffuser

Diffuser is a passive device, it will increases the pressure energy by converting the available kinetic energy at the inlets. The velocity of refrigerant is subsonic in vapor compression refrigeration system and the diffuser can be manufactured with the following dimensions. The diagrams of diffusers as shown below in figure.

Length of diffuser(L)= 9mm Entrance outer diameter(d_1) = 10 mm Entrance inner diameter(d_2) = 6 mm Exit outer diameter (D_1) = 14 mm Exit inner diameter (D_2) = 10mm

Divergence angles of four diffusers (θ)=10°,12°,14°



Experimental set-up with diffuser at condenser inlet

The schematic diagram of vapour compression refrigeration system with diffuser at condenser inlet shown in figure 5. In above set-up one of the diffuser (14°) gives the maximum cop, it will fixed at compressor inlet. Now again testing the four diffusers at condenser inlet same as above. Initially experiment carried without diffuser and readings are noted. Then experiment will repeated with four diffuser by changing one by one and the readings (pressure & temperature) are noted. Diffuser at condenser inlet, it smoothly decelerates the incoming refrigerant float attaining minimum stagnation pressure losses and maximum static pressure recovery. Due to pressure recovery, for same refrigerating effect, compressor has to do less

work. It increases the performance of the

system and also increases the rate of heat transfer in condenser.

- **RESULT**

Diffuser at condenser inlet

Table: 1 summarizes pressure and

temperature readings of refrigerant at various state points as shown in the figure .Table 2 summarizes refrigerating effect, reduction in compressor work and coefficient of performance without and with diffuser conditions.

Pressure and temperature of refrigerant at various state points when diffuser placed at condenser inlet

Calculations:

From the p-h chart of R-134a Refrigerant, the following values can be obtained

h_1 = 437 k_j/k_g h_2 = 510 k_j/k_g h_2 ′= 512 k_j/k_g

$h_1 = h_4 = h_{f3}$ =253 k_j/k_g

Compressor Work (W.D) = h_2 - h_1= 510-437 =73 k_j/k_g

Refrigeration effect = $h_1 - h_4$ = 437-253 =184 k_j/k_g

Diffuser Work=h-h=512-510

Reduction in compressor Work = $(h2 - h1)$ – (h2' -h2)=73-2=71 kj/kg

$$COP_{\text{Without Diffuser}} = \frac{\text{Refrigeration effect}}{\text{Compressor Work}} = \frac{180}{77} = 2.33$$

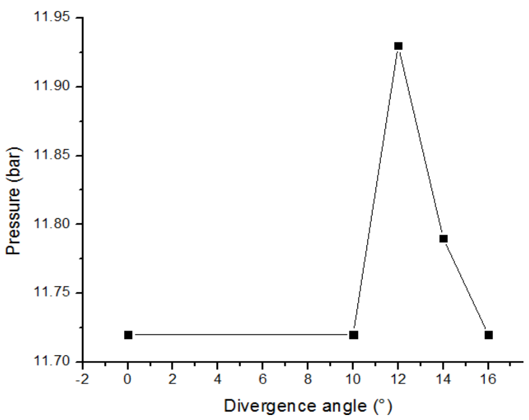
$$COP_{\text{With Diffuser}} = \frac{\text{Refrigeration effect}}{\text{Reduction in Compressor Work}} = \frac{180}{73} = 2.46$$

State points	Position	Pressure (bar)				Temperature (°C)			
			With diffuser				With diffuser		
			10°	12°	14°		10°	12°	14°
1	**Compressor inlet**	0.68	0.68	0.68	0.68	32	34.5	34.5	34.5
2	**Condenser Inlet**	11.72	11.72	11.93	11.79	40.6	40.6	41.9	41.3
3	**Condenser outlet**	11.72	11.72	11.72	11.72	37.6	37.6	37.6	37.6
4	**Evapourator inlet**	0.41	0.41	0.41	0.41	4.3	4.3	4.3	4.3

Table 2: **Refrigerating effect, compressor work and cop for without and with diffuser condition at condenser inlet**

Parameters →		**Refrigerating effect (kj/kg)**	**Reduction in Compressor Work (kj/kg)**	**Cop**
Without Diffuser		184	73	2.52
	10°	184	73	2.52
	12°	184	71	2.59
	14°	184	72	2.55

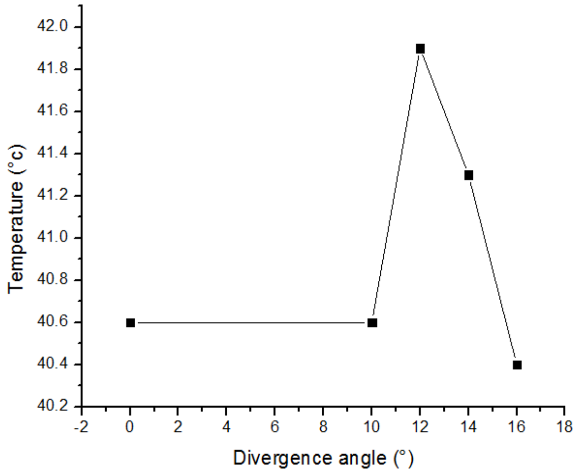
Effect of divergence angles on pressure



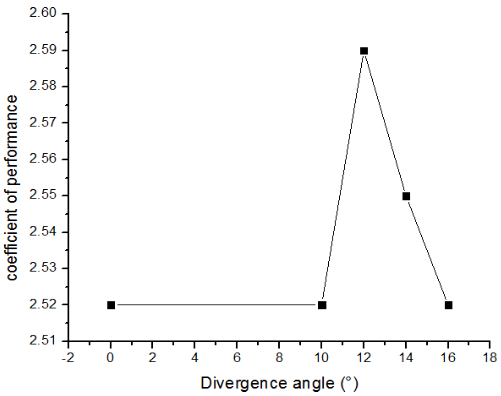
This Figure represents the effect of divergence angles of diffusers on the pressure. It is found that, initially the pressure at 11.72 bar without any diffuser. The pressure is same up to 10° divergence angle and then increases to 11.93 bar at 12° divergence angle. This is the maximum pressure. Then increases the divergence angle pressure decreases up to

Effect of divergence angles on temperature

11.72 bar.



Effect of divergence angles on cop



Variation of cop with diverging angle

Figure shows the variation of cop with respect to divergence angles. It is observed that maximum gain in COP at diffuser with divergence angle 12°at pressure of 11.93 bar. Applying first law thermodynamics to diffuser. It is observed that increase in enthalpy proportional to kinetic energy of the refrigerant. The increase in enthalpy is without consumption of power from system.

Hence, the compression work is reduced for same refrigerating effect, COP of the system is increased. During a process through diffuser, pressure and temperature of refrigerant increases. Due to this variation in pressure and temperature of refrigerant flows through condenser. Hence, the rate of heat transfer increases in condenser.

III. CONCLUSION

Experimental investigation has been carried out to study the effect of diffusers at compressor inlet and condenser inlet on vapour compression refrigeration system. The four diffusers are tested with divergence angles of 10°, 12° and 14° .

1. Diffuser at compressor outlet diffuser with divergence angle 14° given the maximum cop (2.46) as compared to other diffusers. The pressure increases from 0.41 to 0.68 bar and the compressor work reduced by 6%. Percentage of increase in COP is approximately 6%.
2. Diffuser at condenser inlet, diffuser with divergence angle 12° given the maximum cop (2.59) as compared to other diffusers. The diffuser increases the pressure from 11.72 to 11.93 psi and the compressor work reduced by 3%. Percentage of increase in COP is approximately 3%. The rate of heat rejection in condenser is increased when diffuser placed at condenser inlet.
3. When there are using the both diffusers at a time in vapour compression refrigeration system, 14° diffuser at compressor inlet and 12° diffuser at condenser inlet. Then increases more COP than the individual using of diffuser. Percentage of increase in COP is approximately 12%.

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