

EXPERIMENTAL ANALYSIS OF EFFECT OF THE NOZZLE AT THE OUTLET OF CONDENSER ON VAPOUR COMPRESSION REFRIGERATION SYSTEM PERFORMANCE

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Abstract: In vapor compression refrigeration cycle, expansion of refrigerant from condenser pressure to evaporator pressure takes place in a capillary tube, it is proposed to incorporate a nozzle in addition to a capillary tube for expansion. Nozzle is a positive device which converts pressure energy into kinetic energy without aid of any external work.

In the present work it is proposed to use both capillary tube and nozzle to expand the refrigerant from condenser pressure to evaporator pressure with a view to find the effect of nozzle. In view of this, the experimental setup was fabricated and is used to obtain the experimental data. This experimental data is used to analyze the performance of the refrigeration system with and without the nozzle at the outlet of condenser. This present investigation has found that the capillary tube in addition to the nozzle encourages further reduction of pressure before entering into the evaporator. This leads to the improvement of the refrigerating effect and coefficient of performance of the vapour compression refrigeration system.

1. INTRODUCTION

Refrigeration is the removal of heat from a space at a temperature lower than the surrounding temperature. The Coefficient of Performance, which is the ratio of refrigeration effect produced at the heat absorption section to the work input by the compressor. COP can be enhanced either by decreasing the work input of compressor or by increasing the refrigeration effect. The current experimental analysis deals with the effect of the nozzle at the outlet of condenser on vapour compression refrigeration system.

Almost all fractional horse power, vapor compression refrigeration units employ capillary tube. The use being extended presently to large units up to about 3.5K.W. The capillary tube when used as liquid refrigerant expanding device usually consists of an extremely small bore tube from 0.5mm to 2.5mm of about 0.5m to 5m long. Numerous combinations of bore and length are available to get the desired restriction.

The objectives of the domestic refrigerator by using the nozzle at outlet of condenser are given below

1. To fabricate the experimental set up by modifying the domestic refrigerator equipped with nozzle at the outlet of condenser
2. To observe the difference on the Coefficient of performance (COP) of the refrigerator cycle with and without nozzle at the outlet of condenser.

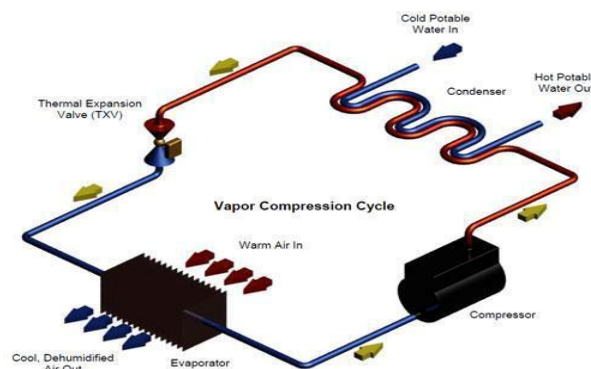


Fig1: Conventional Vapour Compression Refrigeration system

Overview of nozzle:

Nozzle is a positive device which converts the pressure energy into kinetic energy. As the velocity of refrigerant is subsonic in the vapor compression refrigeration system the nozzle is used to increase the velocity of refrigerant. Nozzle can be manufactured with the following dimensions.

Area of entrance = 3.5

For a given pipe of Bore 1/4" (6.35 mm)

Entrance Diameter = 6.35mm

Exit Diameter = 3.39mm

Length of nozzle = 5.638mm

The above dimensions of the nozzle are manufactured on the lathe machine.

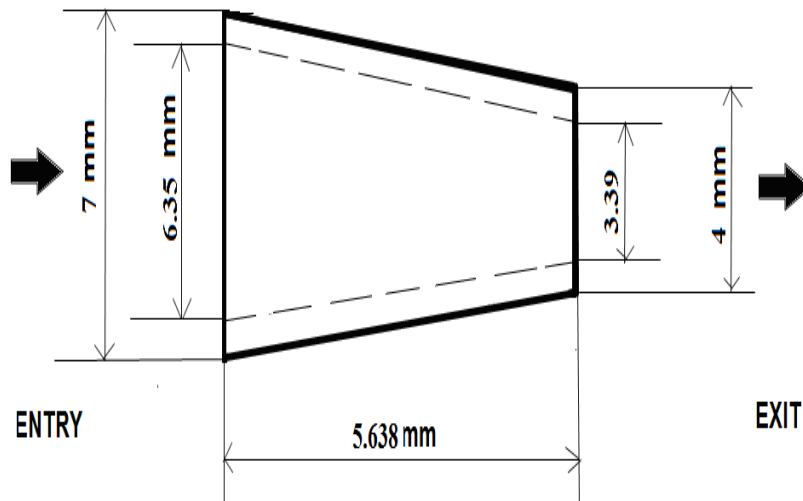


Fig 2:Nozzle

3.EXPERIMENTAL SETUP

In vapour compression refrigeration cycle expansion of refrigerant from condenser pressure to evaporator pressure takes place in capillary tube. In the present experiment, it is proposed to incorporate a nozzle in addition to capillary tube expansion. Nozzle is a passive device which converts the pressure energy into kinematic energy without aid of any external work. In the present work it is proposed to use both capillary tube and nozzle to expand the refrigerant from condenser pressure to the evaporator pressure, with a view to find the effect of nozzle.



Fig 3: Convergent nozzle



Fig 4: Refrigerator with nozzle

4. DATA COLLECTION AND CALCULATION

The following data have been collected for each test run at the steady state condition of the system.

1. P_1 =Compressor suction/Evaporator outlet pressure(bar)
2. P_2 =Evaporator Inlet Pressure(bar)
3. T_2 = Compressor suction Temperature ($^{\circ}\text{C}$)
4. T_3 =Compressor discharge/condenser Inlet Temperature($^{\circ}\text{C}$)
5. T_1 =Evaporator Inlet Temperature($^{\circ}\text{C}$)
6. t = time(min)

Table 1
Experimental Data without nozzle

P_1 (bar)	P_2 (bar)	T_1 ($^{\circ}\text{C}$)	T_2 ($^{\circ}\text{C}$)	T_3 ($^{\circ}\text{C}$)	t (min)
1.2	14.4	26	26.5	42.5	0
1.1	14.7	11	26.2	42.9	2
1.0	14.5	2	25.4	44.2	5
0.8	14.3	-1	25.1	44.8	8
0.7	14	-5	24.6	45.9	12

Table 2
 Experimental Data with nozzle

$P_1(\text{bar})$	$P_2(\text{bar})$	$T_1(^{\circ}\text{C})$	$T_2(^{\circ}\text{C})$	$T_3(^{\circ}\text{C})$	$t(\text{min})$
1.2	13.8	24.1	27	30.5	0
1.1	14.6	14.6	26.6	37.6	2
1.1	15.0	6.8	26	40.2	4
0.9	13.8	-2.6	25.7	43.9	6
0.8	14.0	-9	24.2	46.0	10

5. RESULTS

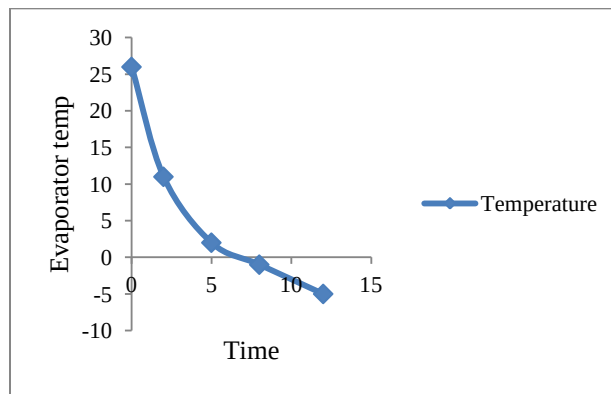


Fig 5: Evaporator temp Vs Time without nozzle

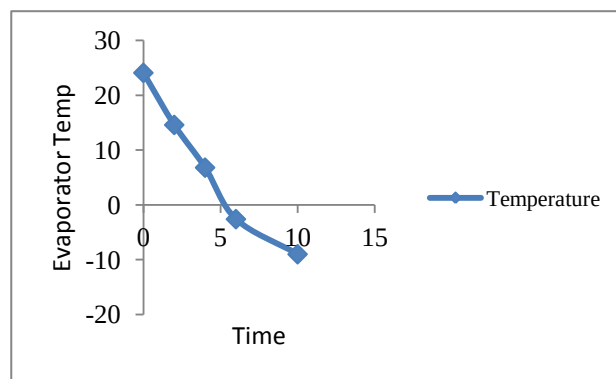


Fig 6: Evaporator temp. Vs Time with nozzle

6. CONCLUSION

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 serves the purpose of 2" capillary tube length. This gives the following results, by maintaining constant pressures.

- 1) Power consumption can be reduced by 8.9%
- 2) COP Of the system increased from 1.86 to 2.4.

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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