EXPERIMENTAL INVESTIGATION OF ACTUAL VAPOUR COMPRESSION REFRIGERATION SYSTEM

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Abstract- Refrigeration refers to the removal of heat from substances under controlled conditions. Reductions are included in the process. Keeping the body temperature and heat lower than the normal temperature of its surroundings. In commercial and domestic use, food products are kept cold. Vapor Compression Refrigeration System (VCRS) is used for cooling and heating. In this paper we are going to calculate the coefficient of performance (cop) of refrigeration in which we are going to use refrigerant. It is used the refrigerant we will be using is R134a also known as tetrafluoroethene. The refrigerant used is R134a which is eco-friendly. The vapor compression process consists of four stages (expansion, compression, condensation and evaporation) which help to transfer heat for refrigeration. Coefficient of performance is very important to find good refrigerant in refrigeration. Refrigerant should be low boiling point, high critical temperature and High latent heat of vaporization which make these properties as good refrigerant. The value of vapor compression refrigeration system by using refrigerant in normal temperature and pressure condition.

Keywords: coefficient of performance (COP), VCRS, Refrigerant, R134a.

1.INTRODUCTION

A vapor compression refrigeration test rig is a laboratory setup used to study the performance and characteristics of a vapor compression refrigeration system. The test rig is designed to mimic a real-life refrigeration system and is used to investigate various parameters such as the effect of evaporator and condenser temperatures, compressor speed, and refrigerant type on the performance of the system. The test rig typically consists of a compressor, a condenser, an evaporator, a refrigerant storage tank, and various control valves and instrumentation. The compressor is responsible for compressing the refrigerant vapor and raising its pressure and temperature. The condenser is used to reject the heat absorbed by the refrigerant during the compression process. The evaporator is where the refrigerant absorbs heat and undergoes a phase change from liquid to vapor. The test rig is used to evaluate the performance of the refrigeration system by measuring various parameters such as the refrigerant flow rate, compressor power consumption, condenser and evaporator temperatures, and pressures at different points in the system. This data can be used to analyse the efficiency and effectiveness of the refrigeration system and make necessary modifications or improvements. Overall, a vapor compression refrigeration test rig is an essential tool for researchers and engineers in the field of refrigeration and air conditioning, as it enables them to study and optimize the performance of refrigeration systems under various conditions. The refrigerant vapor is compressed by means of compressor to a pressure at which temperature obtained at the end of compression will be more then atmosphere so that at this high temperature it will reject heat to atmosphere and will get condensed. [3,4] The condensate is then allowed to pass through a capillary so that the pressure and temperatures and lowered. Capillary device acts as a throttling unit .[5,6] At low pressure and temperature refrigerant is supplied to the evaporator where load is kept, it absorbs the heat and refrigerant get converted into gaseous phase. A vapor compression refrigeration test rig is a laboratory equipment that is designed to test and evaluate the performance of a vapor compression refrigeration system. The refrigeration system is commonly used in air conditioning systems, refrigerators, and other cooling applications. The test rig consists of a compressor, a condenser, an evaporator, and an expansion device. The compressor compresses the refrigerant vapor and pumps it into the condenser, where it is cooled and condensed into a liquid. The liquid refrigerant then flows through an expansion device, which reduces its pressure and temperature, before entering the evaporator. In the evaporator, the refrigerant absorbs heat from the surroundings and evaporates back into a vapor, completing the cycle. The test rig is equipped with various instruments and sensors to measure the performance parameters of the refrigeration system, such as pressure, temperature, and flow rate. The test rig can be used to study the effect of different operating conditions, such as varying the refrigerant type, compressor speed, or evaporator load, on the performance of the system. The results obtained from the test rig can be used to optimize the design and operation of vapor compression refrigeration systems and improve their energy efficiency.

1.1 DESIGN

Compressor: The first component of the system is the compressor, which is responsible for compressing the refrigerant and increasing its temperature and pressure. The selection of a compressor depends on the desired operating conditions, such as the refrigerant being used, the desired cooling capacity, and the operating temperature range.

Condenser: The compressed refrigerant is then passed to the condenser, which is responsible for removing the heat from the refrigerant and releasing it to the surrounding environment. The selection of a condenser depends on the type of refrigerant, the desired cooling capacity, and the available cooling medium.

Expansion valve: After the refrigerant has been condensed, it passes through an expansion valve or a throttle valve, which reduces its pressure and temperature.

Evaporator: The low-pressure, low-temperature refrigerant then enters the evaporator, which absorbs heat from the surrounding environment, thereby cooling it. The selection of an evaporator depends on the type of refrigerant, the desired cooling capacity, and the temperature range of the environment being cooled.

Refrigerant: The choice of refrigerant is an important factor in the design of a vapor compression refrigeration test rig. The refrigerant should have a low boiling point and a high latent heat of vaporization, as well as good thermodynamic properties, to ensure efficient operation.

Piping and fittings: The piping and fittings used in the test rig should be designed to handle the pressures and temperatures of the refrigerant being used and should be made of materials that are compatible with the refrigerant.

Safety features: Safety features such as pressure relief valves, emergency shut-off switches, and alarms should be included in the design of the test rig to prevent accidents and ensure safe operation.

2. LITERATURE REWIEW

Bhagyesh Thalekar , Avinash Barve , Rahul Jangam , et al.(2018) [1], In this paper research observed the performance of different environmental friendly refrigerants. They also observed the effect of working parameters like working pressure and working temperature, which affect the coefficient of performance (cop) of vapour compression refrigeration system. In this work, the performance of vapour compression refrigeration system with the following refrigerant has been use R134a.

Xu Shuxue et al. (2013) [2], In this paper research a thermodynamically analytical model on the two-stage compression refrigeration/heat pump system with vapour injection was derived. The optimal volume ratio of the high-pressure cylinder to the low pressure one has been discussed under both cooling and heating conditions. Based on the above research, the prototype was developed and its experimental setup established. A comprehensive experiment for the prototype has been conducted, and the results show that, compared with the single-stage compression heat pump system, the cooling capacity and cooling COP can increase 5%-15% and 10-12%, respectively.

Christian J.L Hermes, et al. (2014) [3], In this paper research reports a study on reduction of refrigeration charge in vapour compression refrigeration system with a liquid to suction heat exchanger the analysis was carried out for different refrigerant and it was found that reduction of refrigerant charge depends on thermodynamic properties of refrigerant and working conditions.

Xiaoui she et al. (2013) [4], In this paper research proposed a new sub-cooling method for vapour compression refrigeration system depending on expansion power recovery. To drive a compressor of sub-cooling cycle, expander output power is employed. Liquid refrigerant is sub-cooled by using evaporative cooler. This makes a hybrid refrigerant system. Analysis is to done by using different refrigerants and results shows that hybrid vapour compression refrigeration has more (C.O.P) than conventional vapour compression refrigeration system.

N K Mohammed sajid et al. (2012) [5], In this paper research studied the performance of air conditioning system with and without matrix heat exchanger. Experiment is conducted to do comparative analysis of split air conditioning system. Initially performance of conventional split type air conditioning system is evaluated and then the performance of split type air conditioning with matrix heat exchanger is evaluated for different load conditions. result indicates that coefficient of performance of air conditioning system with matrix heat exchanger is better than coefficient of performance of split air conditioning system without matrix heat exchanger. It is observed that power consumption with matrix heat exchanger will also reduce.

S.A.Klein et al. (2013) [6], In this paper research Heat transfer devices are provided in many refrigeration systems to exchange energy between the cool gaseous refrigerant

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leaving the evaporator and warm liquid refrigerant exiting the condenser. These liquid-suction or suction- line heat exchangers can, in some cases, yield improved system performance while in other cases they degrade system performance. Although previous researchers have investigated performance of liquid-suction heat exchangers, this study can be distinguished from the previous studies in three ways. First, this paper identifies a new dimensionless group to correlate performance impacts attributable to liquid-suction heat exchangers. Second, the paper extends previous analyses to include new refrigerants. Third, the analysis includes the impact of pressure drops through the liquid-suction heat exchanger on system performance. It is shown that reliance on simplified analysis techniques can lead to inaccurate conclusions regarding the impact of liquid-suction heat exchangers on refrigeration system performance.

E Hajidavalloo et al. [7] , In this paper to reduce the challenging problem of increase of coefficient of performance of air-conditioning system evaporatively cooled air condenser is used instead of air cooled condenser. Experimental results show that evaporative condenser has better performance than air cooled condenser.

N. Upadhyay, (2014) [8], This paper presents a concept of effect of sub-cooling on performance of refrigeration system. In this a diffuser is used after condenser which converts kinetic energy in to the pressure energy of refrigerant it results in reduction of power consumption and it results in reduction of condenser size. After studying of all above techniques concludes that it will be helpful for future research.

3. METHODLOGY

1. The observe the pressure and temperature form test rig using the R134a refrigerant.
2. The take different reading for compressor condenser, suction temperature, Discharge temperature and Evaporator temperature.
3.
4. Calculate using of the chart (p-h) for R134a refrigerant calculate.
5. Actual coefficient of performance and theoretical coefficient of performance can be calculated.
6. We get find Actual coefficient of performance and theoretical coefficient of performance.

3.1 OBSERVATION TABLE

4.

Sr.no	Description	Symbol	reading
1	Evaporator pressure	P_e	1 bar
2	Condenser pressure	P_c	15 bars
3	Evaporator Inlet Temperature	t_{ei}	6 °C
4	Evaporator outlet Temperature	t_{eo}	26 °C
5	Condenser Inlet Temperature	t_{ci}	32 °C
6	Condenser Outlet Temperature	t_{co}	40 °C
7	Temperature of water	t_w	21 °C
8	Time for 10 revolution or Pulses of energy meter of compressor	T_c	6 °C
9	Time for 10 of Energy water	T_n	24.47 sec

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RESULT AND DISCUSSION

Sr no.	Theoretical COP	Actual COP
1.	3	1.10
2.	3.5	1.28
3.	4	1.47

4.1. Graph comparison Theoretical COP and Actual COP

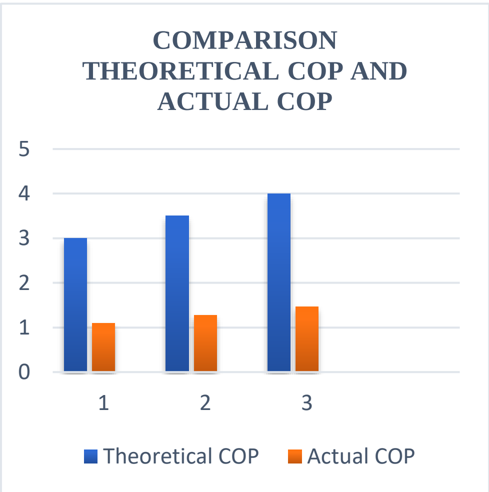
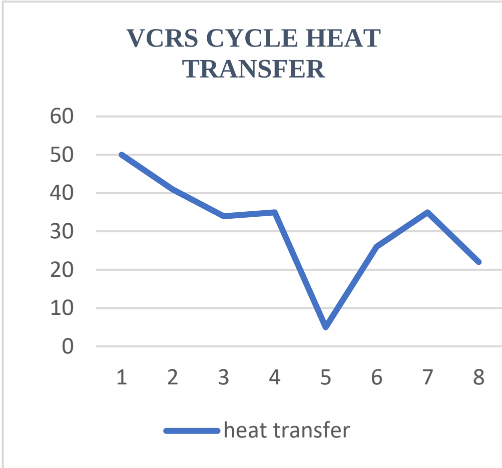


Fig no.1 Theoretical Cop and Actual Cop

From above graph it is clear that theoretical COP is higher than Actual COP as the time increase the theoretical and actual COP is also increases. At 5min trial we find that the Actual COP is 1.10 whereas the theoretical COP is 3. Further increase in time the actual COP is also increases from 1.10 to 1.28 and theorical COP from 3 to 3.5. Also, after 15 min of trial we find that theoretical COP increases from 3.5 to 4 and Actual COP from 1.28 to 1.47.



4.2 Graph VCRS Cycle Heat Trans

Fig no.2 VCRS CYCLE HEAT TRANSFER

1) Discharge temperature 50 ℃
2) Condenser inlet temperature 41 ℃
3) Condenser discharge temperature 34 ℃
4) Filter drier inlet temperature 34 ℃
5) Evaporator inlet temperature 4 ℃
6) Evaporator discharge temperature 26 ℃
7) Compressor suction temperature 28 ℃
8) Water tank temperature 22 ℃

4.3 Graph Discharge Pressure and Suction Pressure

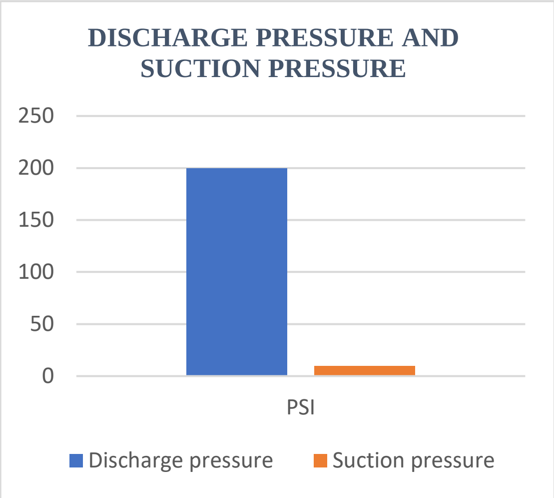


Fig no.3 Discharge Pressure and Suction Pressure

From Above Graph the Difference between of the Compressor discharge pressure and Suction Pressure is 200 PSI and the suction pressure is 10 PSI. Form the above graph we have concluded the discharge pressure is higher than the suction pressure.

5.CONCLUSION

Performance evaluation of vapor compression refrigeration system (VCRS) by using R134a refrigerant was studied, based on the experimental setup, the effect of different working parameters. R134a is one of the important refrigerants used in refrigeration system. The result obtained showed that as discharge temperature and energy increase while the coefficient of performance COP should be increase, highest COP of system is Carnot COP and actual COP is less than theoretical COP can be obtain.

After blending different concentration of using R134a as a refrigerant, we have reached to some important conclusions which are listed the thermal conductivities of nano refrigerants are higher than traditional refrigerants. It was also observed that increased thermal conductivity of nano refrigerants is comparable with the increased thermal conductivities of other nanofluids.

Vapor compression refrigeration is a widely used method for cooling and air conditioning applications. It involves compressing a refrigerant gas, which then releases heat as it condenses into a liquid. The liquid refrigerant then flows through an evaporator where it absorbs heat and evaporates back into a gas. This cycle is repeated to provide continuous cooling.

Vapor compression refrigeration systems are highly efficient and have a relatively low environmental impact when compared to other cooling methods. They are also highly adaptable and can be used in a variety of applications, from small residential air conditioning units to large industrial refrigeration systems.

However, vapor compression refrigeration systems also have some drawbacks, including the potential for refrigerant leaks, which can contribute to environmental degradation and global warming. Additionally, these systems require a significant amount of energy to operate, which can contribute to greenhouse gas emissions and energy costs.

Overall, vapor compression refrigeration is a highly effective and widely used method for cooling and air conditioning, but it is important to consider the potential environmental impact and energy efficiency of these systems.

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