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IMPROVED V.C.R. SYSTEM BY USING SUB- COOLING AND DIFFUSER

Amit Narwal[1]*, Sarvesh Kumar[2], Rishabh Verma[3], Ravi Kumar[4]

**[1]Asstt. professor department of Mechanical Engineering, [2,3,4]Student (B.Tech 5th sem) Department of Mechanical Engineering, *[1,2,3,4]Dronacharya College of Engineering, Gurgaon-123506, India*

**[1]Email: amitnarwaldce@gmail.com, [2] sk8058@gmail.com, [3] yas.rishab@gmail.com, [4] ravikumar3752@gmail.com*

****Corresponding Author: -***

Email: amitnarwaldce@gmail.com

Abstract: -

This paper aims to improve coefficient of performance of system. To improve the coefficient of performance, it should be noted that compressor work should decrease and refrigerating effect should increase. Modifications in condenser are meant to increase degree of sub-cooling of refrigerant which increased refrigerating effect or more cooling water is required in condenser. The purpose of a compressor in vapour 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 tube, liquid hump and damage to condenser by erosion. It is needed to convert this kinetic energy to pressure energy by using diffuser. By using diffuser power consumption is less for same refrigerating effect so performance is improved.

Keywords*: -* *vapour compression refrigeration system, sub- cooling and diffuser.*

I. INTRODUCTION

Vapour compression refrigeration system is based on vapour compression cycle. Vapour compression refrigeration system is used in domestic refrigeration, food processing and cold storage, industrial refrigeration system, transport refrigeration and electronic cooling. So improvement of performance of system is too important for higher refrigerating effect or reduced power consumption for same refrigerating effect. Many efforts have to be done to improve the performance of VC refrigeration system.

Jianlin Yu presented a novel auto cascade refrigeration cycle (NARC) with an ejector. In the NARC, the ejector is used to recover some available work to increase the compressor suction pressure. The NARC enables the compressor to operate at lower pressure ratio, which in turn improves the cycle performance.

Zhu and Jiang developed a refrigeration system which combines a basic vapour compression refrigeration cycle with an ejector cooling cycle. The ejector cooling cycle is driven by the waste heat from the condenser in the vapour compression refrigeration cycle. The additional cooling capacity from the ejector cycle is directly input into the evapourator of the vapour compression refrigeration cycle the system analysis shows that this refrigeration system can effectively improve the COP by the ejector cycle with the refrigerant which has high compressor discharge temperature.

N.D. Banker, P. Dutta, M. Prasad and K. Srinivasan present the results of an investigation on the efficacy of hybrid compression process for refrigerant HFC 134a in cooling applications. The conventional mechanical compression is supplemented by thermal compression using a string of adsorption compressors. It is shown that almost 40% energy saving is realizable by carrying out a part of the compression in a thermal compressor compared to the case when the entire compression is carried out in a single-stage mechanical compressor. The hybrid compression is feasible even when low grade heat is available. Some performance indicators are defined and evaluated for various configurations

Lorenzo Ferrari and Fabio analyze a complex system in which the solar powered ejection machine is used to increase the efficiency of a traditional vapour compression machine by subtracting heat from the condenser. By means of a transient analysis, performed with a reference building and with climate data corresponding to four different system locations worldwide, the year-round performance of such a system in a space cooling application is estimated in terms of energy balance and savings on power costs with respect to the traditional solutions

A. Selvaraju and A. Mani investigate the experimental analysis of the performance of a vapour ejector refrigeration system. The system uses R134a as working fluid and has a rated cooling capacity of 0.5 kW. The influence of generator, evapourator and condenser temperatures on the system performance is studied. For a given ejector configuration, there exists an optimum temperature of primary vapour at a particular condenser and evapourating temperatures, which yields maximum entrainment ratio and COP.

L. Kairouani, M. Elakhdar, E. Nehdi and N. Bouaziz [6] presented an improved cooling cycle for a conventional multi-evapourators simple compression system utilizing ejector for vapour precompression is analyzed. The ejector enhanced refrigeration cycle consists of multi-evaporators that operate at different pressure and temperature levels. A one-dimensional mathematical model of the ejector was developed using the equations governing the flow and thermodynamics based on the constant-area ejector flow model. The theoretical results show that the COP of the novel cycle is better than the conventional system.

Advances in condenser to increase coefficient of performance means to increase degree of sub-cooling, F. W. Yu and K. T. Chan [7] described use of direct evapourative coolers to improve the energy efficiency of air-cooled condenser. This evapourative cooler is installed in front of air-cooled condenser to pre-cool outdoor air before entering the condenser. Results were predicted that the use of the evapourative cooler results in an increase in the refrigeration effect.

Present work deals with the improvement of vapour compression refrigeration system by using sub-cooling and diffuser at inlet of condenser.

II. Theoretical analysis

Simple vapour compression cycle:

Dry saturated vapour coming from evapourator is compressed in compressor so pressure is increases superheated vapour is passed through condenser where vapour is condensed by flowing the cooling water in condenser. Dry saturated liquid is passed through expansion valve where expansion takes place so pressure is decrease by expansion after expansion liquid is passed in evapourator where it absorb the heat of storage space and evapourate so cooling process in storage space is achieved, thus cycle is complete.

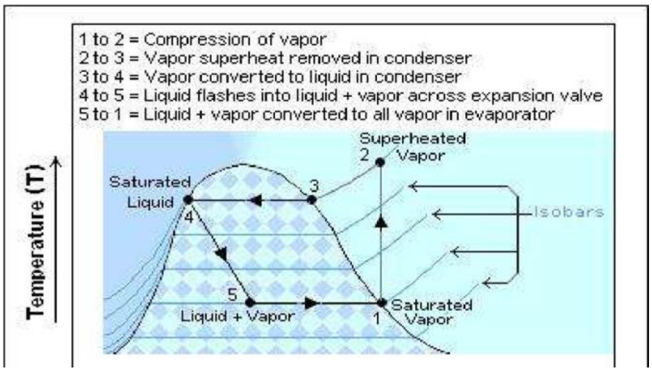


Fig.II.1 T-S diagram for VC Cycle [8]

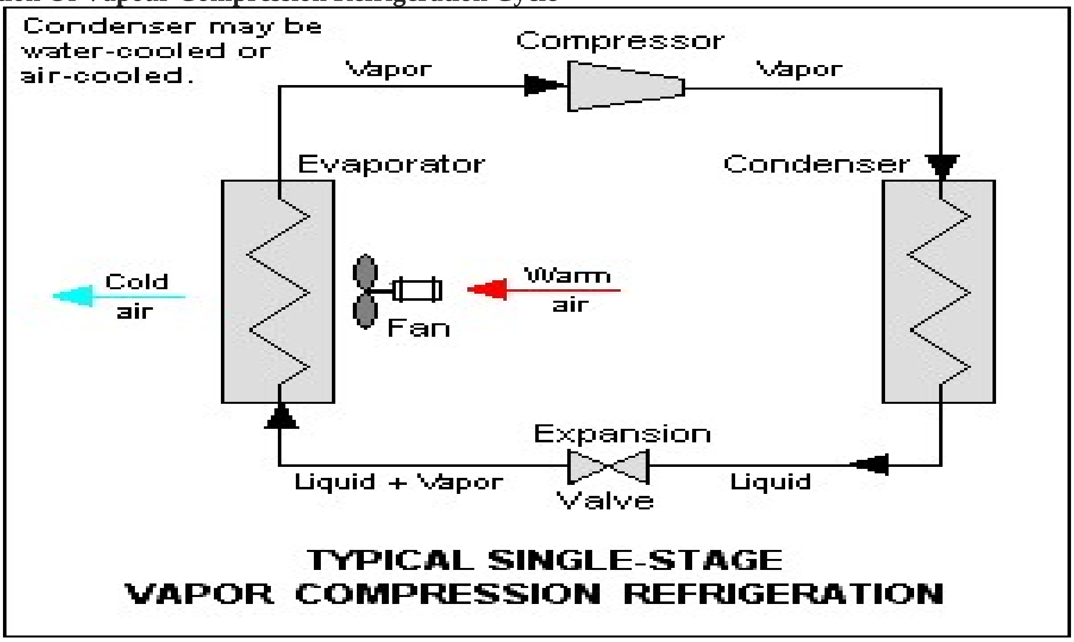
COP ______________ COP (Coefficient of Performance): it is a performance parameter of simple VC Cycle. If refrigerating effect increases or work input decreases than performance of simple VC Compression cycle increases.

Applications of Vapour Compression Refrigeration Cycle:

Vapour-compression refrigeration is one of the many refrigeration cycles and is the most widely used method for air-conditioning of buildings and automobiles. It is also used in domestic and commercial refrigerators, largescale warehouses for chilled or frozen storage of foods and meats, refrigerated trucks and railroad cars, and a host of other commercial and industrial services. Oil refineries, petrochemical and chemical proc essing plants, and natural gas processing plants are among the many types of industrial plants that often utilize large vapour-compression refrigeration systems.

Refrigeration may be defined as lowering the temperature of an enclosed space by removing heat from that space and transferring it elsewhere. A device that performs this function may also be called an air conditioner, refrigerator, air source heat pump, water source heat pump, geo thermal heat pump.

Description Of Vapour Compression Refrigeration Cycle



The vapour-compression uses a circulating liquid refrigerant as the medium which absorbs and removes heat from the space to be cooled and subsequently rejects that heat elsewhere. Figure 1 depicts a typical, single-stage vapourcompression system. All such systems have four components: a compressor, a condenser, a thermal expansion valve (also called a throttle valve or metering device), and an evapourator. Circulating refrigerant enters the compressor in the thermodynamic state known as a saturated vapour and is compressed to a higher pressure, resulting in a higher temperature as well. The hot, compressed vapour is then in the thermodynamic state known as a superheated vapour and it is at a temperature and pressure at which it can be condensed with either cooling water or cooling air. That hot vapour is routed through a condenser where it is cooled and condensed into a liquid by flowing through a coil or tubes with cool water or cool air flowing across the coil or tubes. This is where the circulating refrigerant rejects heat from the system and the rejected heat is carried away by either the water or the air (whichever may be the case).

The condensed liquid refrigerant, in the thermodynamic state known as a saturated liquid, is next routed through an expansion valve where it undergoes an abrupt reduction in pressure. That pressure reduction results in the adiabatic flash evapouration of a part of the liquid refrigerant. The auto-refrigeration effect of the adiabatic flash evapouration lowers the temperature of the liquid and vapour refrigerant mixture to where it is colder than the temperature of the enclosed space to be refrigerated.

The cold mixture is then routed through the coil or tubes in the evapourator. A fan circulates the warm air in the enclosed space across the coil or tubes carrying the cold refrigerant liquid and vapour mixture. That warm air evapourates the liquid part of the cold refrigerant mixture. At the same time, the circulating air is cooled and thus lowers the temperature of the enclosed space to the desired temperature. The evapourator is where the circulating refrigerant absorbs and removes heat which is subsequently rejected in the condenser and transferred elsewhere by the water or air used in the condenser.

To complete the refrigeration cycle, the refrigerant vapour from the evapourator is again a saturated vapour and is routed back into the compressor.

Vapour compression cycle with sub-cooling and using diffuser:

In the present cycle, the vapour refrigerant leaves the compressor with high velocity. This high velocity refrigerant directly impinges on the tube of condenser which may damage to it by vibration and erosion. It results undesirable splashing of refrigerant in the condenser tube. It also results a phenomenon called as “liquid hump”. Liquid hump refer 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. It reduces the heat transfer surface area so reduce condenser efficiency. Thus reducing the velocity of refrigerant a diffuser is attached after compressor. Diffuser is a device which converts the velocity into pressure energy. It smoothly decelerates the incoming refrigerant achieving minimum stagnation pressure losses and maximizes static pressure recovery [9]. Due to pressure recovery, at same refrigerating effect compressor to do less work. Hence, power consumption of the compressor will be reduced which results improvement in system efficiency. Superheated vapour is passed through condenser where condensation takes place. More amount of water is flow in condenser so refrigerant vapour is cooled below the condensing temperature at constant pressure thus sub-cooling is achieved. By sub cooling enthalpy of vapourization of refrigerant is increases thus more amount of heat is absorbed by refrigerant in evapourator for evapouration takes place, so refrigerating effect is increases thus performance of cycle is increased. After sub-cooling liquid refrigerant is passed through expansion valve where expansion takes place and passes through evapourator where absorb the latent heat from storage space and evapourate. Thus cooling is achieved in storage space.

III.Result and discussion

By sub-cooling enthalpy of vapourization of refrigerant is increases so refrigerating effect are increases thus COP increases. By using diffuser after compressor high velocity is converted into pressure. Some part of required pressure increases in diffuser and some amount of pressure increases in compressor so compressor work is decreases or power consumption is decreases. Thus performance or COP is increases.

IV. Conclusion

COP of Vapour Compression Cycle is increased by lowering the power consumption /work input or increasing the refrigerating effect. By using sub-cooling and using diffuser at condenser inlet refrigerating effect increases and power consumption or work input decreases. Thus performance of cycle is improved. High velocity refrigerant has various serious affect on vapour compression refrigeration system such as liquid hump, undesirable splashing of the liquid refrigerant in the condenser and damage to the condenser tubes by vibration, pitting and erosion. Diffuser is such a device to reduce high velocity of refrigerant is the conversion of some amount of kinetic energy into pressure energy without work consumption.

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