A Review on Analysis of Vapour Compression Refrigeration System Using Matrix Heat Exchanger

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Abstract- Power consumption is a major concern in vapor compression cycle .The objective of this research paper is to study the performance of a vapour compression refrigeration system with and without a Matrix Heat Exchanger. The concept of analytical study of vapour compression refrigeration system using matrix heat-exchanger carried out to improve the coefficient of performance of system. To improve the coefficient of performance, it is required that compressor work should decrease & refrigerating effect should increase. Most of the refrigeration system uses conventional vapour compression refrigeration (VCR) cycle which has a low Co-efficient of Performance (C.O.P), But installing a heat exchanger to the vapour compression refrigeration system (VCR) makes it more efficient.

Keywords – Vapour compression system, Matrix heat exchanger, R-134a, C.O.P, Power consumption.

I. INTRODUCTION

The conventional fuel sources are getting depleted due to continuous use of it. Conventional energy sources are not long lasting. Now a days energy is continuously in demand and the world is on the one hand facing problem with limited availability of conventional energy sources and on the other hand global warming because of pollutants from fossil fuels. Refrigeration systems are indispensable for human beings in the modern life.

Currently, the mechanical vapour compression systems used for this purpose, use large amounts of electrical power that is produced in great proportion by fossil fuel combustion, which is a cause of the global warming. Global warming makes imperative need to develop alternative technologies that will allow carrying out cooling applications reducing the use of electrical energy. Electrical energy can be remarkably saved by incorporating high efficiency devices or occupying other energy sources such as thermal energy.

Vapor compression refrigeration system is based on vapor compression cycle. Vapor compression refrigeration system is used in domestic refrigeration, food processing and cold storage, industrial refrigeration system, transport refrigeration and electronic cooling. Coefficient of performance of performance of refrigeration system is the ratio refrigerating effect to the work done. So improvement of performance of system is too important to increase refrigerating effect or to reduce work done by compressor. Many efforts have to be done to improve performance of vapor compression refrigeration system.

II. LITERATURE REVIEW

Xu Shuxue et al. (2013) [1], 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 have 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. Also, the heating capacity with the evaporating temperature ranging from 0.3 to 3OC is 92-95% of that under the rate condition with the evaporating temperature of 7 OC, and 58% when the evaporation temperature is between 28 ^{O}C and 24^{O}C.

Christian J.L Hermes, (2014) [2], 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) [3], 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 have more (C.O.P) than conventional vapour compression refrigeration system.

N K Mohammed sajid et al. (2012) [4], 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) [5], Heat transfer devices are provided in many refrigeration systems to exchange energy between the cool gaseous refrigerant 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. [6] , in this paper to reduce the challenging problem of increase of coefficient of performance of air-conditioning system evapouratively 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) [7], 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.

III. MATRIX HEAT EXCHANGER

The necessity of high effectiveness in a small volume has led to the development of perforated plate matrix heat exchangers (MHE) for refrigeration applications applications. Although the basic principles have remained the same, the techniques of fabrication and bonding have changed considerably during the last four decades. The large surface area of each perforated plate gives the matrix heat exchanger a large surface area to volume ratio, enabling compact exchangers with high heat transfer.

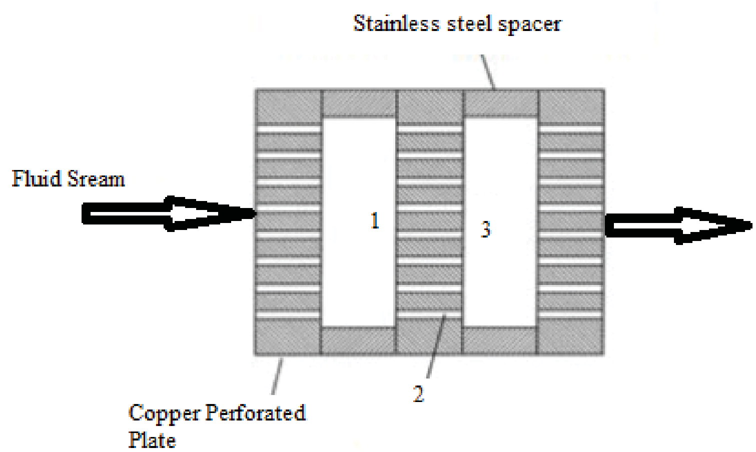

Figure 1 cross section of a matrix heat exchanger

1) The front face of the plates
2) The tubular surface of the perforations
3) The back face of the plates

Figure 1 shows a cross section of a matrix heat exchanger to indicate the three different convective heat transfer surfaces. While efficient, the heat transfer process in a matrix heat exchanger is complex, as there are two conduction paths (along the perforated plates, and across the spacer plates), as well as three convection surfaces (upstream of the plates, downstream of the plates, and the inner wall surface area of each perforation).
The total heat transfer of a matrix heat exchanger is composed of five components: 1) Convective heat transfer between hot fluid streams and perforated plates. 2) Conductive heat transfer along the perforated plates up to the separation wall. 3) Conductive heat transfer across the separation wall. 4) Conductive heat transfer along the perforated plates from the separation wall. 5) Convective heat transfer between perforated plate and cold fluid stream. All these modes of heat transfer (convection on three different surfaces and conduction in two different directions) are coupled, requiring them to be determined together. This project surveys the available literature for applications of matrix heat exchangers in steam generation, which will result in the ability to design a more efficient and more compact refrigeration system.

IV. PROPOSED WORK

To study the coefficient of performance of the proposed system as shown in figure, in basic vapour compression refrigeration system vapour refrigerant is compressed in the compressor and then compressed refrigerant is condensed inside the condenser. In condenser liquid vapour refrigerant is converted in liquid form where it reject its heat. Liquid refrigerant is passed to evaporator through expansion device. In evaporator liquid refrigerant absorb heat and get converted into vapour form.

In proposed vapour compression refrigeration cycle a counter flow matrix heat exchanger is placed after condenser. A special arrangement is made by providing two valves to do comparative analysis of coefficient of performance of refrigeration system with and without matrix heat exchanger. In matrix heat exchanger liquid refrigerant after condenser is passed through the matrix heat exchanger and one another stream is provided from which partial liquid vapour mixture from condenser is passed through matrix heat exchanger. This results in sub cooling of liquid refrigerant. As sub-cooling occurs coefficient of Performance of refrigeration system may increase.

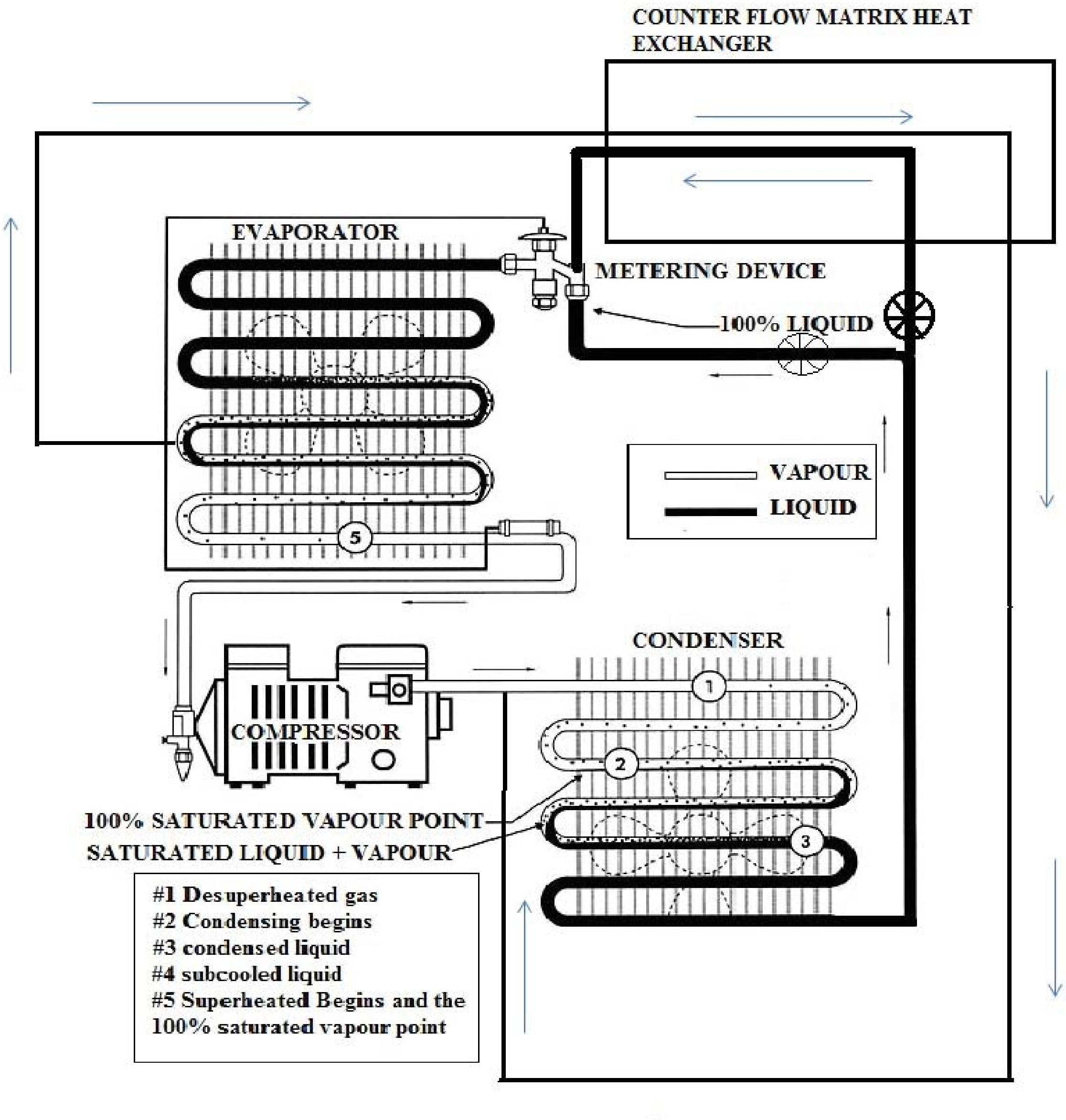

Figure 2 Proposed vapour compression refrigeration system using matrix heat exchanger

V.CONCLUSION

Vapour refrigeration system requires large amount of energy to operate. As energy crisis is big problem in the world there is a need of decreasing power consumption of electricity. Energy consumption can be reduced by using counter flow matrix heat exchanger. As energy consumption is reduced coefficient performance of refrigeration system may increase.

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