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DESIGN AND DEVELOPMENT OF VAPOUR COMPRESSION REFRIGERATION SYSTEM USING LIQUID HEAT EXCHANGER

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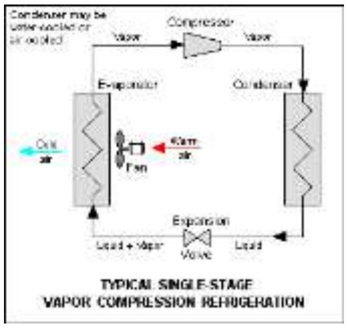
Abstract - *In recognition to the increasing effect of existing refrigerants & Vapour Compression Refrigeration System(V.C.R.S.) which uses it,their is a need to change the system and refrigerants to reduce the Global Warming Potential(GWP) & Ozone Depletion Potential(ODP),along with this it will also has to increase the C.O.P. of the system.So in our project we use the Liquid Heat Exchanger & take the blend of R600a and R290 as the refrigerant and another refrigerant HFO-1234yf and calculate the COP of the system and found that in both cases the coefficient of performance(COP) of the system will increase and GWP & ODP was reduced as compared to the existing V.C.R.S. system and currently used refrigerant R134a.By using the Liquid Heat Exchanger we are able to reduce the load on compressor so as to get the more and more cooling effect with minimum input and less harm to the environment. Through this project, we are able to reduce the Global Warming Potential(GWP) i.e.,4 which is nearly 1300 in case of R134a and the Ozone Depletion Potential(ODP) was already zero.So we successfully fabricate and test the Vapour Compression Refrigeration System using Liquid Heat Exchanger with the reduction in the Environmental pollution and the improved COP of the system.*

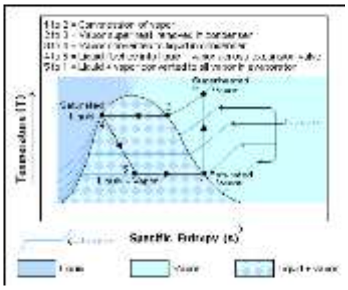
Key Words: Refrigerants, V.C.R.S., liquid Heat Exchanger, Global Warming Potential, Ozone Depletion Potential…

1.INTRODUCTION

Refrigeration is the process of cooling a space, substance, or system to lower and/or maintain its temperature below the ambient one (while the removed heat is rejected at a higher temperature). In other words, refrigeration means artificial (human-made) cooling. Heat is removed from a low-temperature reservoir and transferred to a high-temperature reservoir. Refrigeration has had a large impact on industry, lifestyle, agriculture, and settlement patterns.

1.1 Vapor-compression cycle





The vapor-compression cycle is used in most household refrigerators as well as in many large commercial and industrial refrigeration systems. Figure 1 provides a schematic diagram of the components of a typical vapor-compression refrigeration system.

The thermodynamics of the cycle can be analyzed on a diagram as shown in Figure 2. In this cycle, a circulating refrigerant such as Freon enters the compressor as a vapor. From point 1 to point 2, the vapor is compressed at constant entropy and exits the compressor as a vapor at a higher temperature, but still below the vapor pressure at that temperature. From point 2 to point 3 and on to point 4, the vapor travels through the condenser which cools the vapor until it starts condensing, and then condenses the vapor into a liquid by removing additional heat at constant pressure and temperature. Between points 4 and 5, the liquid refrigerant goes through the expansion valve (also called a throttle valve) where its pressure abruptly decreases, causing flash evaporation and auto-refrigeration of, typically, less than half of the liquid.

1.2 Necessities of Refrigeration

1.Domestic-In domestic for storing the food and other material to keep it in well condition,
2.Commercial-For human comfort
3.Cold storage-For storing fruits and agricultural products,
4.Ice factory-To produce ice for various use,
5. In transportation
6.For storing medicines and human organs and death bodies.

1.3 Major Elements of Refrigeration System and their Functions

1.3.1 Condenser

Condensation changes gas to a liquid form. Its main purpose is to liquefy the refrigerant gas sucked by the compressor from the evaporator. As condensation begins, the heat will flow from the condenser into the air, only if the condensation temperature is higher than that of the atmosphere. The high-pressure vapour in the condenser will be cooled to become a liquid refrigerant again, this time with a little heat. The liquid refrigerant will then flow from the condenser to a liquid line.

1.3.2 Compressor

The compressor's use is to pull the low-temperature and low-pressure vapour from the evaporator, through a suction line. Once the vapour is drawn, it will be compressed. This will cause the vapour's temperature to rise. Its main function is to transform a low-temperature vapour in to a high-temperature vapour, to increase pressure. Vapour is released from the compressor into a discharge line.

1.3.3 Evaporator

An evaporator is used to turn any liquid material into gas. In this process, heat is absorbed. The evaporator transfers heat from the refrigerated space into a heat pump through a liquid refrigerant, which boils in the evaporator at a low-pressure. In achieving heat transfer, the liquid refrigerant should be lower than the goods being cooled. After the transfer, liquid refrigerant is drawn by the compressor from the evaporator through a suction line. Liquid refrigerant will be in vapour form upon leaving the evaporator coil.

1.3.4 Expansion Valve

Commonly placed before the evaporator and at the end of the liquid line, the expansion valve is reached by the liquid refrigerant after it has been condensed. Reducing the pressure of the refrigerant, its temperature will decrease to a level below its atmosphere. This liquid will then be pumped into the evaporator.

1.3.5 Heat exchanger

A heat exchanger is a system used to transfer heat between two or more fluids. Heat exchangers are used in both cooling and heating processes.The fluids may be separated by a solid wall to prevent mixing or they may be in direct contact.

2. LITERATURE REVIEW

[1] From this study they conclude that, an ideal vapour-compression refrigeration system is used for the performance analysis of alternative new refrigerant mixtures as substitutes for CFC12, HFC134a, and CFC22. Considering the comparison of performance coefficients (COP) and pressure ratios of the tested refrigerants and also the main environmental impacts of ozone layer depletion and global warming, refrigerant blends of HC290/HC600a (40/60 by wt.%) and HC290/HC1270 (20/80 by wt.%) are found to be the most suitable alternatives among refrigerants tested for R12 and R22 respectively. The refrigeration efficiency, the performance coefficient (COP) of the system, increases with increasing evaporating temperature for a constant condensing temperature in the analysis. All systems including various refrigerant blends were improved by analysing the effect of the superheating/subcooling case. Better performance coefficient values (COP) than those of the non-superheating/subcooling case are obtained as a result of this optimization.

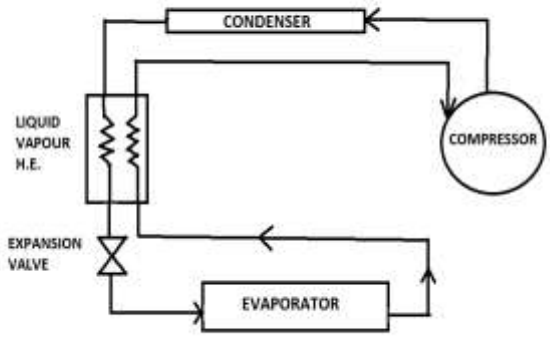
[2] From this study they found that as per the Kyoto and Montreal protocols, the harmful refrigerants are to be phased out and are to be replaced with alternate environmental friendly refrigerants. The objective of this paper is to evaluate different environmental friendly refrigerant. On the basis of collecting information, the following conclusions may be drawn. HFCs can replace R-22 without any modification in the system. Despite having the advantage of zero ODP, the system delivers the poor performance with increased energy consumption as compared with R-22. Hydrocarbons and their various blends may replace R-134a without any system modifications. COP of the system is improved with reduced energy consumption.The system delivers better performance than with pure refrigerant; the energy consumption is also reduced. However optimum blend composition for

maximum performance of the system is not much studied. Research work for deciding the concentration of blends has to be undertaken to have better performance of the system.

[3] They concluded after their study that project invested an ozone friendly, energy efficient, user friendly, safe and cost-effective alternative refrigerant for HFC134a in domestic refrigeration systems. After the successful investigation on the performance of HCs and blends of HCs as refrigerants the following conclusions can be drawn based on the results obtained. The energy consumption of the pure HCs and blends of HCs is about similar to the energy consumption of refrigerator when HFC134a is used as refrigerant. The compressor consumes 2% and 3% less energy when Butane and Iso-butane was used than that of HFC-134a at 28 ambient temperature. • HCs and mixture of HCs offer lowest inlet refrigerant temperature of evaporator. So for the low temperature application HCs and blends of HCs is better than HFC-134a. This indicates the possibility of using HCs as an alternative of HFc-134a in the existing refrigerator system. Chemical and thermodynamics properties of hydrocarbon meet the requirement of a good refrigerant.The final conclusion is that butane and isobutene can be used in the existing refrigerator-freezer without modification of the components.

3. METHODOLOGY

In our work,we use the Liquid heat exchanger after the condenser in order to reduce the load on compressor and also along with that we take Hydro-Fluoro-Olefin(hfo-1234yf) and the blend of R600a and R290 which results in the reduction in the Global Warming Potential(GWP) & Ozone Depletion Potential(ODP).The experimental set-up of the work is shown in the figure below:-



4. CONCLUSIONS

From the work,we conclude that by using Hydro-Fluoro-Olefin(hfo-1234yf) as the refrigerant we get very low GWP i.e.;4 with zero ODP.It has low toxicity,excellent COP and Capacity.Also it doesn't have glide temperature.This characteristic properties will results in the increase in COP of the system & reduce in the energy consumption of the system.The blends of R600a & R290 results in neglisible Green House Effect,strong cooling performance,low toxicity,high solubility with conventional lubricants and ester oils due to their individual characteristic properties.

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