PERFORMANCE ANALYSIS OF VAPOUR COMPRESSION REFRIGERATION SYSTEM USING MIXED REFRIGERANTS OFR134A and R404A

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Abstract—*In this analysis the Performance of Compression cycle is assessed theoretically with different refrigerants. In compression refrigeration system, Hydrofluoric refrigerants such as R134A and R404A are considered as a refrigerant by mixing of these as different mass fractions. Various performance measures like compressor, discharge temperature, pressure ratio, Volumetric cooling capacity, volumetric efficiency and mass flow rate are analyzed. The results are compared with halogenated refrigerant such as R134A and R404A for different condenser and evaporator temperature. The new blend gives performance better than existing refrigerant. The mixing or blended of two or more refrigerant with exact blending ratio gives the highest rate of COP and low ozone depletion potential. The exact mixture was identified by verifying the properties of selected refrigerants .There are various combination of refrigerants and the mixture should be selected based on theoretical calculation of Coefficient of Performance.*

Keywords—Hydro-FluoroCarbon,Refrigerants, ozone,friendly,Performance-charecteristics, Refrigeration-system,ozone-depletion potential, Global Warming potential.

1. INTRODUCTION

Vapor compression Refrigeration system is a system which is used to transfer heat from low temperature reservoir to high temperature reservoir with the help of working fluid. The household refrigerator is working under the VCR system. The ozone depletion potential and global warming potential have become the most important criteria in the development of new refrigerants CFCs due to their contribution to ozone layer depletion and Global warming. In spit of their high GWP,alternatives to refrigerants CFCs and HCFCs such as hydro fluorocarbon refrigerants with zero ODP and hydrocarbon refrigerants have been preferred for use in many industrials and domestic applications. The problems of the depletion of ozone layer and increases in global warming caused scientist to investigate to more environmentally friendly refrigerants than HFC refrigerants for the protection of the environmental such as hydrocarbon refrigerant.

The vapor compression use a circulating liquid refrigerant as the medium which absorbs and remove heat from the space to be cooled and subsequently rejects the heat elsewhere. All such system have four components compressor, evaporator, expansion valve, condenser. Circulating refrigerant enters the compressor in the thermodynamic state known as saturated vapor and is compressed to a high pressure , resulting in a high temperature as well.

The hot, compressed vapor is then in the thermodynamic state known as superheated vapor and it is at a temperature and pressure at which it can be condensed with either cooling water or cooling air. That hot vapor 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 a coil or tubes. This is where the circulating refrigerant heat from the system and the rejected heat is carried away by either the water or the air.

The condensed liquid refrigerant, in the thermodynamic state known as a saturated liquid, in next routed through an expansion valve where it undergoes an abrupt reduction in pressure. That pressure reduction result in the adiabatic flash evaporation of a part of the liquid refrigerant. The auto refrigeration effect of the adiabatic flash evaporation lowers the temperature of the liquid and vapor 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 evaporator's farm circulate a worm air in the enclosed space across the coil or tubes carrying the cold refrigerant liquid and vapor mixture. That warm air is evaporate the liquid part of the cold refrigerant mixture. At the same time circulating air is cooled and thus lowers the temperature of the enclosed space to the desired temperature.

TABLE 1:PROPERTIES OF R134A AND R404A REFRIGERANT

Refrigerant	R134A	R404A
Chemical composition	CH2FCF3	CHF_2CF_3, CH_2FCF_3, CH_3CF_3
Molecular weight (g/mol	102.03	97.6
Critical temperature (oC)	101.06	127.23
Critical pressure (MPa)	4059	4956
Normal boiling point (oC)	–26.07	-47.8
ODP	0	0
GWP	1300	3260

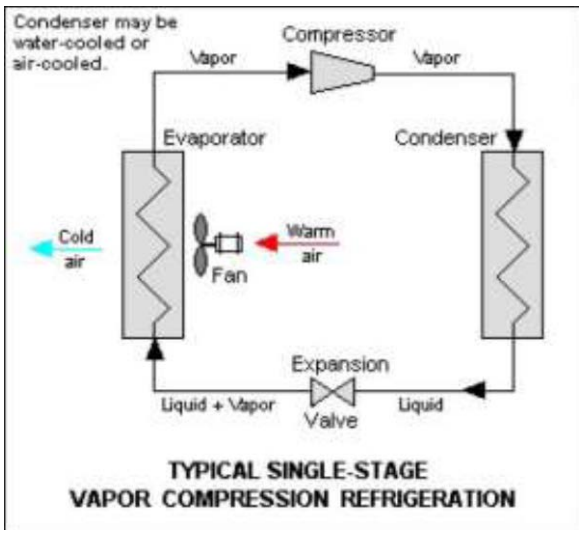
The evaporator is where the circulating refrigerant absorbs and remove heat which subsequently rejected in the condenser and transferred elsewhere by the water or air on the condenser

The condensing and evaporating pressure are determined corresponding to the condensation and evaporation temperature. The condensation temperature is decidedly the temperature of the ambient air, whereas the evaporation temperature is determined by the load temperature based on the required freezer air temperature. The performance parameter of the VCR system are Coefficient of Performance, is the ratio of refrigeration effect to the work done. The energy balance of the evaporator and compressor gives refrigeration effect and work done

In this experiment the hydro fluorocarbon refrigerant of R134Aand R404A Mixed at the various ration for zero ozone depletion potential at the different evaporative temperature and Mixture.

2. THEORY OF VAPOR COMPRESSION REFRIGERATION SYSTEM

The vapor compression refrigeration system is most commonly used domestic refrigeration. In VCR the refrigerant alternatively undergoes a change of phase from vapor to liquid and vice versa during a cycle. The system consist of compressor, conducer, expansion valve, evaporator. The liquid refrigerant which is at low pressure and low temperature flows into the compressor



TYPICAL SINGLE-STAGE VAPOR COMPRESSION REFRIGERATION

In the compressor refrigerant is compressed and converted into a high pressure and high temperature. This high pressure and high temperature refrigerant then passes through then condenser where it is condensed into high pressure liquid refrigerant. The high pressure liquid refrigerant Is then pass through the expansion valve where it pressure and temperature drops and it partly evaporates. It is then allowed to the evaporator at a controlled rate. In the evaporator the partially liquid and vapor refrigerant is evaporated and converted into a low pressure vapor. During this process the refrigerant absorbs its latent heat of vaporization from the material to be cooled. Thus body is cooled in the evaporator by continually extracting heat

2.1 REASONS FOR SELECTION MIXTURE OF HYDROFLUOROCARBON OF R134A and R404A REFRIGERANT

Refrigerant	R134A	R404A
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- The mixture of hydro fluorocarbon refrigerant of R134A and R404A refrigerants has the following advantages
- Improve the overall efficiency by 10%
- Zero ozone layer depletion and global warming potential are significant ally negligible are compared to other refrigerant
- Environmental friendly
- It does not form acids and thereby eliminate this the problem with blocked capillaries
- Low viscosity and high thermal conductivity that guarantee good performance of the refrigeration system
- As density is less than lower than CFCs in spits of its flammability, the refrigerant mass requirement are low

2.2 OBJECTIVES OF THIS PROJECT

The main objectives of this project work are as follows

- To develop a household VCR system designed to work with R134A as an investigation to unit assess to prospect of using mixed refrigerants.
- Experimental studies in the VCR system with R134A and identified best refrigerant mixture in place of R134A
- Comparison of COP for the different refrigerant mixture and R134A by experimental results
- Comparison of GWP for the different refrigerant mixtures and R134A
- Comparison of energy consumption rate of the system when using different refrigerant mixtures and R134A by experimental results
- To suggest the best composition of refrigerant mixture to get the maximum COP with the minimum GWP
- compressor manufactures more on realistic basis than on conservative basis in which case condenser size will work out to be too large.

3. EXPERIMENTAL PROCEDURE

The refrigerant were prepared by a commercial refrigeration mixture. The mixture were prepared by two hydrofluoro carbon refrigerant such as R134A,R404A,Air

temperature in the frozen food storage compartment are monitored and recorded continuously.

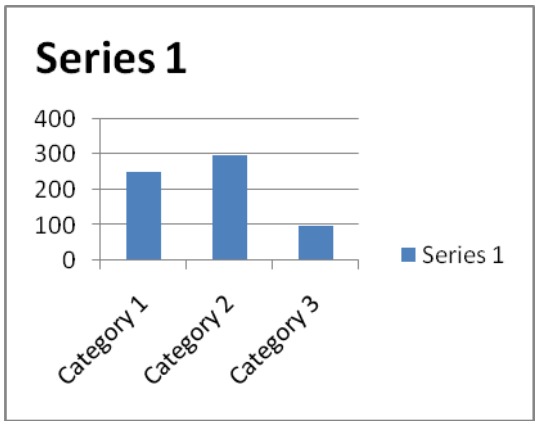
The properties of the mixture shows that the alternative mixture 1,mixture 2, mixture 3, mixture 4.During the experimentation the atmospheric is maintained at 28+-2c.The experimental procedures were repeated and taken the reading by using different mixtures in the same test unites in the various mode .The following parameters are calculated based on the observed values

- Pull down time
- COP
- Power consumption
- Suction and discharge pressure

3.1 Experimental Results

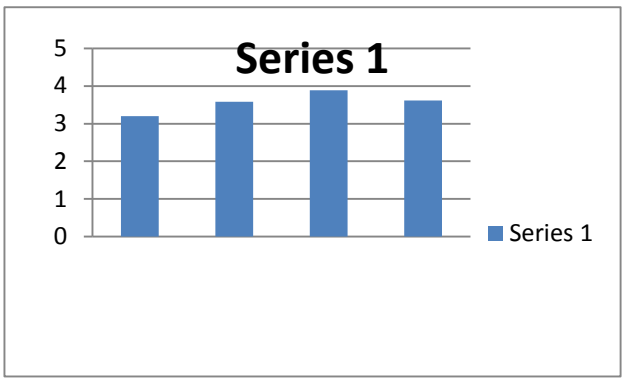
The Following Results are determind by the different mass fraction of refrigerant R134A

R134A(X=COP,Y=Enthalpy)



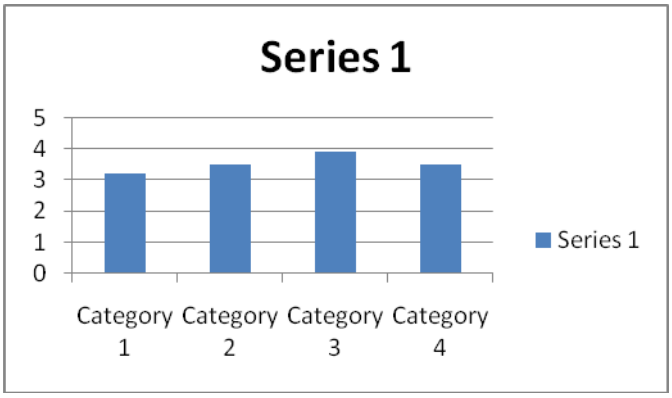
3.2 RESULTS AT MIXED REFRIGERANTS:

In this diagram present the HFC refrigerant of R404A and R134a is mixed with a proportion of 1/0,0.75/0.25, 0.5/0.5, 0.75/0.25, for reducing the ozone depletion potential and improving the COP values and the properties of the refrigerants



COMPARISON CHART

In this results the COP values of R134A,R404A,50%+50%(R134A+R404A),25%+75%,



COP values are increasing only in the mixture of 50%+50 of R134A+R404A refrigerant, and also compare the value with the single refrigerant of R134A and R404A refrigerants and the properties are also calculating

Specifications

Compressor -1/8 hp reciprocating compressor
Condenser -Fin type condenser
Liquid filter - Micro filler
Expansion devices - Capillary tube diameter (0.036 inches)
Expansion devices - Capillary tube Length-10 feet
Evaporator -Coil diameter- ¼ inch length
Evaporator - Length 11 feet
Evaporator -4 liters flask capacity

4. RESULTS AND DISCUSSIONS

This project work deals with hydeofluorocarbon mixed refrigerant in order to asses their feasibility for domestic refrigeration system by comparing their relevant parameters. The experiment was conducted based on the standard methods without modifying the components of the refrigerators. The distributions temperature in the frozen food storage compartment in the refrigerator, energy consumed by compressor, refrigerant temperature and pressure at the inlet and outlet of the compressor were continually recorded and discussed in detail. this project was carried out in the following ten methods

- Conducting experiment with HFC refrigerants of R134A and R404A
- Observing the performance refrigerators when using mixed refrigerant of R134Aand R404A with different load condition
- Comparison of saturated and temperature and pressure for mixed refrigerant at different load condition
- Comparison of Coefficient Of Performance for R134Aand different mixed refrigerants
- Comparison of refrigeration effect for different mixed refrigerants
- Comparison of specific work for mixed refrigerants
- Comparison of Global Warming Potential for different refrigerant mixed refrigerant
- Comparison of energy consumption rate of different refrigerant mixtures

That results are compared and find out of the different mixed refrigerant and the single refrigerants

5. CONCLUSION

This work investigated an ozone friendly, energy efficient, user friendly, safe and cast effective alternative refrigerant for R134Aand R404A in domestic refrigeration system. After the successful investigation on the performance of mixed refrigerants the following conclusion can be drawn based on the result obtained. This experiment investigation carried out to determine the performance of a domestic refrigerator when a m0069ed of R134A and R404A refrigerant is used.The only drawback of HFC blend is the GWP. The drawback of using R134A,R404A with respect to GWP can be overcome by mixing that refrigerants with an appropriate mass fraction. So that the final mixture leads to decreased GWP due to less mass fraction of R134A and R404A .With these advantages final ternary mixture which is obtained with the composition of 50%R134A,50%R404A will be environmental friendly alternative refrigerant. In the present work investigation have been successfully made to use ternary mixture of R134A/R404A.An improvement in energy efficiency of the new mixture has also been demonstrated in this work. The results of the present work indicate the successful use of this mixed refrigerant of HFC R134A and R404A refrigerants in domestic refrigerator.

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