iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 6 **Issue:** VI **Month of publication:** June 2018

DOI: http://doi.org/10.22214/ijraset.2018.6050

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue VI, June 2018- Available at www.ijraset.com

Performance Analysis of Domestic Refrigerator Using Mixed Refrigerants

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***Abstract**: In this project is present in this project is present on mixed refrigerants used in domestic refrigerators to better performance. The performance of refrigerator depends on inlet and outlet conditions. So this project work obtain domestic refrigerator in terms of refrigeration effect, compressor work and cop. performance of refrigerator using tetrafluroethene (R134a) and (R407a) refrigerants in mixture of . Finally comparison made of R134a and mixture refrigerants.*
***Keywords**: Cop, blended refrigerant's, Refrigeration effect, volumetric capacity. Work input.*

I. INTRODUCTION

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. This systems have four components: a compressor, a condenser, a thermal expansion valve (also called a throttle valve), and an evaporator. Circulating refrigerant enters the compressor in the thermodynamic state known as a saturated vapor and is compressed to a higher pressure, resulting in a higher temperature as well. The hot, compressed vapor is then in the thermodynamic state known as a 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 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 evaporation of a part of the liquid refrigerant.

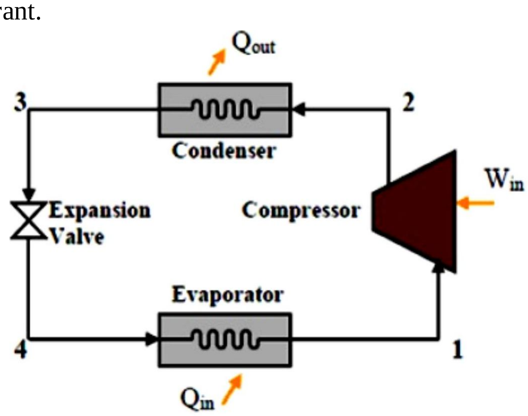

Fig. 1 VCR System

Components of Refrigeration system,

A. Compressor

It compresses the refrigerant. The compressor receives low pressure gas from the evaporator and converts it to high pressure gas. As the gas is compressed, the temperature rises. The hot refrigerant gas then flows to the condenser.

B. Condenser

A condenser is a device or unit used to condense a substance from its gaseous to its liquid state, by cooling it. In so doing, the latent heat is given up by the substance, and will transfer to the condenser coolant.

C. Expansion Valve

Its function is to meter the amount of refrigerant to be supplied to evaporator and to reduce the pressure up to evaporator pressure such that liquid can vaporise at the evaporator coil.

D. Evaporator

An evaporator is used in an air-conditioning system to allow a compressed cooling refrigerant, to evaporate from liquid to gas while absorbing heat in the process. It can also be used to remove water or other liquids from mixtures.

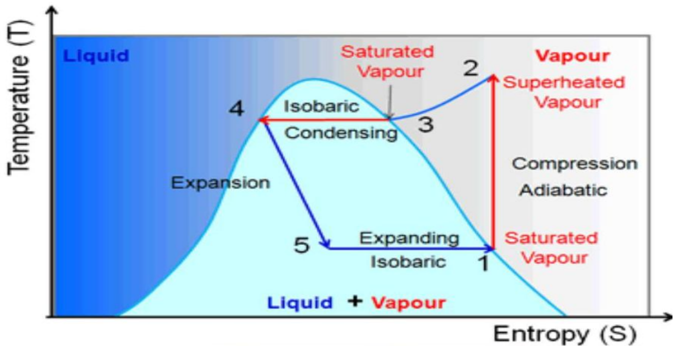

Fig. 2 T-S diagram VCRS

Process 1-2: Isentropic compression of saturated vapour in compressor
Process 2-3: Isobaric heat rejection in condenser
Process 3-4: Isenthalpic expansion of saturated liquid in expansion device
Process 4-1: Isobaric heat extraction in the evaporator
Expansion is a constant enthalpy process. It is drawn as a vertical line on the above P-h diagram. No heat is absorbed or rejected during this expansion, the liquid just passes through a valve, like water coming out of a tap. The difference is, that because the liquid is saturated at the start of expansion by the end of the process it is partly vapour. Point 1 is inside the curve and not on the curve as described in the Evaporation process. The refrigerant at the beginning of the vaporization is already partly evaporated. This depends on the shape of the curve, and the start and end pressures.

E. Co-Efficient Of Performance

The performance of a refrigerating system is expressed by a term known as the co-efficient of performance which is defined as the ratio of heat absorbed by a refrigerants to the work input required to the compress the refrigerants.

C.O.P = Rn / W

Where,

Rn – Net refrigeration effect
W – Work required (or) work done
Relative C.O.P = Actual C.O.P/Theoretical C.O.P
Actual C.O.P = Rn / W

Table 1 Latent Heat Of Commonly Used Refrigerants

Substance	Latent Heat Fusion kJ/kg	Melting Point °C	Latent Heat Vaporization kJ/kg	Boiling Point °C
Ammonia	339	−75	1369	−33.34
Carbon dioxide	184	−78	574	−57
Nitrogen	25.7	−210	200	−196
R134a	-	−101	215.9	−26.6

F. Rating of Refrigerants

The rating of a refrigerating machine is obtained by refrigerating effect or amount of heat extracted in a given time from a body. It is given by ton of refrigeration which is defined as the refrigeration effect produced by the melting of 1 ton of ice at 0 C in 24 hours.

A ton of refrigeration = (336 x 1000/24) = 14,000 kJ/hr.

G. Enthalpy

Enthalpy is a measure of the total energy of a thermodynamic system. It includes the internal energy, which is the energy required to create a system, and the amount of energy required to make room for it by displacing its environment and establishing its volume and pressure.

H. Selection of Refrigerants

A variety of refrigerants are used in vapour compression systems. The required cooling temperature largely determines the choice of fluid. Commonly used refrigerants are in the family of chlorinated fluorocarbons (CFCs, also called Freon's): R-11, R-12, R-21, R-22 and R-502. The properties of these refrigerants are summarized in Table 1 and the performance of these refrigerants is given in Table below.

Table 2 Properties Of Commonly Used Refrigerants

Ashrae	Molecular mass	Normal boiling	Critical temperature (^oC)	Critical pressure (kpa)
R600a	58.1	-11.7	134.7	3640
R732	32	-182.95	-118.6	5050
R744	44	-78	31.08	7308
R702	2.016	-152.87	-239.95	1300
R501	93.1	-41	96.19	4765
R123	152.9	27.6	183.68	3662
R143a	84	-47.6	72.81	3776
R113	187.4	48	214.06	3392

I. Classification of Refrigerants

The refrigerants may broadly classified into two types

1) Primary refrigerants
2) Secndary refrigerants

The refrigerants which directly takes part in the refrigeration system is called primary refrigerants where as the refrigerants which cooled by the primary refrigerants and then used for cooling purpose is known as secondary refrigerants.

Primary refrigerants are classified into the following types: They are

3) Halo carbon refrigerants
4) Azeotropic refrigerants
5) Inorganic refrigerants
6) Hydrocarbon refrigerants

Table 3 Properties Of R407a (R32+R125+R134a)

Critical temperature in °C	658.6
Molecular weightin kg/kmol	90.1
Normal boiling point in °C	-49.9
Pressure at -25 °C in bar (absolute)	0.58
Liquid density at -25 °C in kg/l	84.92
Enthalpy of vaporisation at -25 °C in kJ/kg	90.3

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Table 4 Properties Of R134a

Critical temperature in °C	101
Molecular weight in kg/kmol	102
Normal boiling point in °C	-26.5
Pressure at -25 °C in bar (absolute)	1.07
Liquid density at -25 °C in kg/l	1.37
Enthalpy of vaporisation at -25 °C in kJ/kg	216

J. Exprimental Set Up

SPECIFICATION

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 8 feet
Evaporator	-4 liters flask capacity

Fig. 3 Experimental setup

This Section provides the information about the how I was developed the experiment set up and how I will carry out the test procedure the during experiment. First the experiment test ring developed from the refrigerator model. To perform the experiment and develop the test ring 4 L refrigerator is selected. and Fig. shows the diagram of test ring and connection point of pressure and temperature measurement.

Now from the experiment test ring there 4 point of temperature measurement and 2 point of pressure measurement. Two point of pressure measurement one of the one point in suction side and another point is in discharge line. The pressure gauge are used for the pressure measurement so compound gauge is fitted on discharge line due to high pressure and vacuum gauge is fitted on suction line due to low pressure as shown in the fig. Now there four points is temperature measurement so one the point of temperature measurement is in evaporator means in the freezer compartment of refrigerator. Two points is for the measurement of food storage

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cabinet. And point is located on the compressor inlet, compressor outlet, and condenser inlet and condenser outlet. So now for the temperature measurement digital thermometer are used. Ammeter is also used for the current measurement. So this the procedure of the experiment set up.

Now for the test procedure the evacuation and vacuuming is done by the another compressor. And vacuum is done up to the 25in/hg. This is required for the cleaning of the lines by removing moisture, air and oil. Now after that the refrigerant is charged by the charging system and when the evaporator temp. set at 10°c and 1st I charged the R 134a and collected the data like pressure and temperature every 15 minutes during the running the refrigerator and also collected the data various evaporator temperature. After collecting the data R 134a is removed and refrigerator are charged by another alternative refrigerant like R 32-20%, R125-40%, R 134a-40% and mixture of the different refrigerant and collected the data. After collecting the experimental data I found different parameter like COP, Refrigerant effect, Compressor power, Volumetric cooling capacity, and then compare this data each other to the refrigerant and find the alternative refrigerant which gives the better performance in compare with R 134a So in this way I will be found the best alternative of R 134a.

II. RESULT AND DISCUSSION

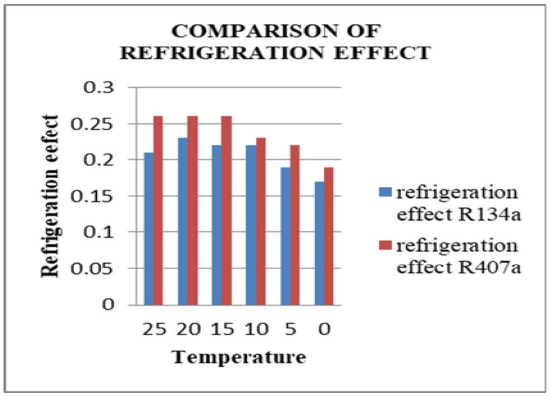

Fig. 4 Comparison of refrigeration effect

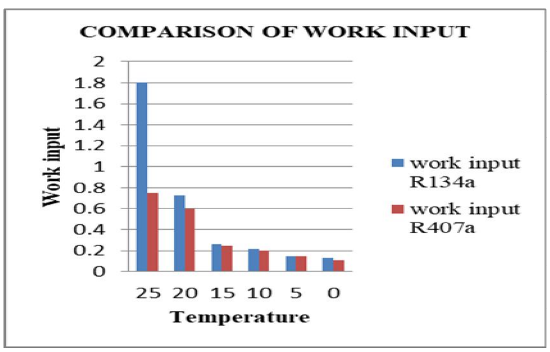

Fig. 5 Comparison of work input

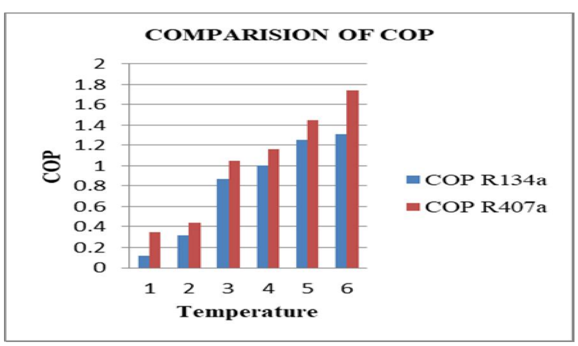

Fig.6 comparison of COP

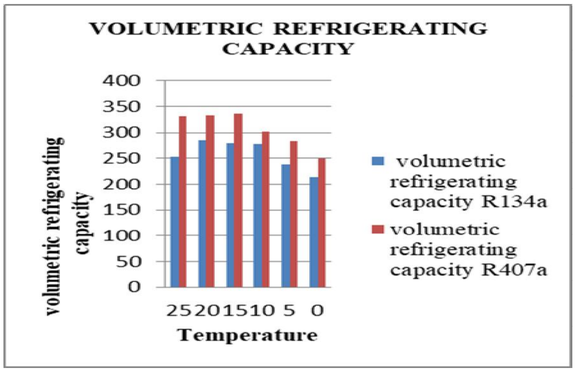

Fig. 7 Comparison of volumetric refrigerating capacity

III. CONCLUSIONS

Vapour compression refrigeration using HCFC refrigerants is the most desirable technology for domestic and commercial refrigeration in the present scenario. So environmental friendly refrigerants are used to reduce the emission of CFC's from refrigerators and protect the ozone layer from depletion. The Co-efficient of Performance will be increased by mixing the blended refrigerants. An examination of the possibility of enhancing the performance of a vapour compression refrigeration system has improved the performance in this experiment. In this investigation the combinations of 20% R32 + 40% R125+ 40% R134a has reduced the Ozone Depletion Potential and have increased the Co-efficient Of Performance.

IV. ACKNOWLEDGMENT

I am very grateful and gifted in taking up this opportunity to thank the god for powering his unlimited blessings upon us.
I take this occasion to express my gratitude to our chairman dr. A.k natesan, mba., m.phil., ph.d.,and vice chairman dr.n.mathan karthik, mbbs., for facilitating in this bravura college.
I wish to express my sincere thanks to our principal dr.v.k.shumughanaathan ph.d., excel engineering college, for his stable and ethical support to finish my project successfully.
I express my deep sense of gratitude to our esteemed head of the department dr.g.nallakumarasamy ph.d., department of mechanical engineering excel engineering college, for his scintillating discussion and encouragement towards my project work.
We express our sincere thanks to our beloved project coordinator, mr.n.tamilselvan, m.e., (phd) assistant professor, department of mechanical engineering who is always with us to carry out this project successfully.
I am immensely pleased to thank my internal guide mr.p.jegadeshwaran, m.e., assistant professor, department of mechanical engineering for his excellent guidance and co-operation during the project work.
I express sincere words of gratitude to other faculty members and staff members of the department of mechanical engineering.
My family and friends were the always rooting me on to finish. I also extend my warmest thanks to all our lab technicians for helping me in this venture.

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