IJNRD.ORG ISSN : 2456-4184
INTERNATIONAL JOURNAL OF NOVEL RESEARCH AND DEVELOPMENT (IJNRD) | IJNRD.ORG
An International Open Access, Peer-reviewed, Refereed Journal

EXPERIMENTAL ANALYSIS ON THE PERFORMANCE OF VAPOUR COMPRESSION REFREGERATION SYSTEM USING DIFFERENT REFRIGERENTS - A REVIEW

1. Mr. Amit Pandey, 2. Dr.Ajay Singh, 3. Prof. Nitin Barodia,

1 PG Scholar, Department of Mechanical Engineering, RITS Bhopal, MP, India.
2 Professor & Head, Department of Mechanical Engineering, RITS Bhopal, MP, India.
3 Asst. Professor, Department of Mechanical Engineering, RITS Bhopal, MP, India

ABSTRACT: The design of capillary tube plays a very important role in the performance of a vapor compression refrigeration system. Optimized designis possible through theoretical calculations, however may fail due to the reason that the uncertainties in theformulation of pressure drop inside the capillary tubes. Hence experimental investigations are the best in terms of optimization of certain design parameters. Components of the vapor compression refrigeration system never work in isolation; change in performance of one component affect theperformance of the other components and in turn overall performance of the system. Performance of the system also depends on the type, quantity of the refrigerant charged. In the present work, an attempt is made to optimize Length of capillary tube for refrigeration unit of capacity 30lts; with R-134a as refrigerant and hermetic sealed compressor of capacity 0.14H.P.and this study examined the effects of lengths capillary tubes on the performance of a vapor compressionrefrigeration system. It is found that 4.5feet Length ofcapillary tube gave a better performance. Both inlet and outlet pressure and temperature of the test section(capillary tube) were measured and used to estimate the coefficient of performance (COP) of the system the parameters stated above can be further optimizedin order to enhance the performance of the refrigeration system.

Keywords: - Vapor compression Refrigeration System, capillary tube, refrigerants, coefficient of performance.

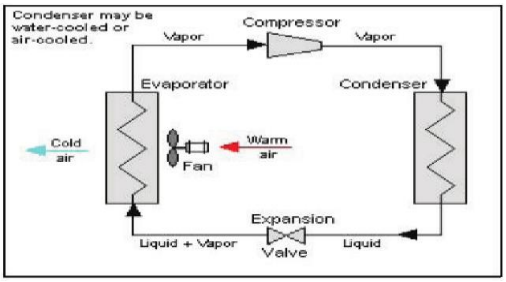
1. INTRODUCTION

Refrigeration is the 'artificial' extraction of heat from a substance in order to lower its temperature to below that of its surroundings. Primarily, heat is extracted from fluids such as air and many liquids, but ultimately from any substance. In order to extract heat a region of 'cold' has to be created. In thermodynamic terms a refrigerator is a reversed heat engine. I.e. heat may transfer from a cold reservoir to a hot reservoir by expending work. Modern refrigerators operate by the same reverse-heat-engine principle. Whereas a heat engine converts heat (from a high-temperature area) to work, a refrigerator converts work to heat. Modern refrigerators use substances other than air as the coolant; the coolant substance changes from gas to liquid as it goes from higher to lower temperature. This change from gas to liquid is a phase transition, and the energy released upon this transition is mainly dependent on the intermolecular interactionsof the substance. Refrigeration maintains the temperature of the heat source below that of its surroundings while transfer- ring the extracted heat and any required energy input, to a heat sink, atmospheric air, or surface water. A refrigeration system is a combination of components and equipment connected in a sequential order to produce the refrigeration effect.

1.1 Types of Refrigeration System:

The different type of refrigeration system are :

- **Vapor Compression Refrigeration-** Vapor refrigeration system is a technology used for cooling purposes. It's commonly used in refrigerators, air conditioners, and heat pumps. The system works by transferring heat from a cool area to a warm area using a refrigerant. It involves a compressor, condenser, expansion valve, and evaporator to complete the refrigeration cycle. The compressor compresses the refrigerant vapour, causing its temperature and pressure to rise. Then, the high-pressure vapour flows into the condenser, where it releases heat and transforms into a high-pressure liquid. The liquid refrigerant then passes through the expansion valve, where it expands and becomes a low-pressure liquid. Finally, the low-pressure liquid enters the evaporator, where it absorbs heat from the surrounding area and evaporates back into a low-pressure vapour. This cycle repeats to provide cooling.



vapor compression refrigeration system, [16]
fig. 1

- **Vapor Absorption Refrigeration**- The vapor absorption refrigeration system is another type of cooling technology, like vapor compression. It also operates using a refrigerant, but it relies on absorption and not compression. The system consists of an absorber, generator, condenser, evaporator, and a solution of refrigerant and absorbent. In the absorption refrigeration system, the refrigerant vapor is absorbed by the absorbent, forming a refrigerant-absorbent mixture.
- **Air Refrigeration**- Air refrigeration systems also known as air-cycle refrigeration systems, are cooling systems that utilize air as the refrigerant instead of a liquid or gas refrigerant. These systems are commonly used in aircraft, where the weight and safety considerations of other refrigerants make them less practical. In an air refrigeration system, the cooling process is achieved by the expansion of compressed air.
- **Steam Jet Refrigeration**- Steam jet refrigeration systems, also known as steam ejector refrigeration systems, are a type of refrigeration technology that uses steam as the working fluid. These systems are commonly used in industrial and commercial applications. In a steam jet refrigeration system, the refrigeration process is achieved through the principle of the Ventura effect. The system consists of a steam ejector, condenser, evaporator, and a cooling load.
- **Non conventional Refrigeration**- Refrigeration means to extract heat. A refrigeration system extracts heat at low temperatures and rejects it to the higher ambient temperature. This is done by the help of a working fluid called the refrigerant.

1.2 Applications of Refrigeration System: The applications of Refrigeration System are as follows.
Refrigeration is extensively used for increasing the storage life of perishable items especially food products, vegetables, fruits, milk, beverages, chilling of water, ice formation, etc.
Industrial applications include chemical manufacturing, petroleum refinery, petrochemical plants, paper, and pulp industry, etc. Ice making, Manufacturing and treatment of metals, Industrial air-conditioning, Transportation of food, Chemical and related industries, Freezing food products, Medical and surgical aids, Central air-conditioning

1.3 Merits of Refrigeration System: The Advantages of Refrigeration are as follows.
- The basic advantage of air refrigeration is the working substance which is always available in the atmosphere.
- The refrigerant (air) is free of cost and the system is simple to understand.
- The refrigerant keeps the container cool by breaking the bacterial involvement.
- There is no danger of fire due to the leakage of refrigerant from the pipes (if any).

1.4 Demerits of Refrigeration System: The Disadvantages of Refrigeration System are as follows.
- The running cost of the refrigeration is high because the Coefficient of Performance (C.O.P) is very low.
- Per One Tonne of refrigeration, the quantity of refrigerant used is high compared to other systems.
- In Environment, as the air contains moisture which can affect the danger of frosting at the valves.

2.0. Literature Review

S.K.gugulothu et.al [1] The performance parameters such as pull-down time, desired effect, power consumption, and running cost of the system are to be analysed at different eve-orator temperatures, the mass of refrigerant and varying length of capillary tubes. To evaluate the refrigeration effect, Power consumption and COP of the domestic refrigerator at various freezer temperatures (–9°C, –12°C & –15°C) were selected. Results report that out of all the alternative mixtures the amount of energy input was less consumed in the case of HCM1 at a minimal expansion length of 6.3 mm. In the case of HCM5, the least energy was consumed at a capillary length of 5.24 mm whereas in the case of R134a it was at 3.3 mm.

y. chandrasekhar yadav et.al [2] the design of capillary tube plays a very important role in the performance of a vapour compression refrigeration system. Optimized design is possible through theoretical calculations, however may fail due to the reason that the uncertainties in the formulation of pressure drop inside the capillary tubes. Hence experimental investigations are the best in terms of optimization of certain design parameters. Components of the vapour compression refrigeration system never work in isolation; change in performance of one component affect the performance of the other components and in turn overall performance of the system. Performance of the system also depends on the type, quantity of the refrigerant charged.

Miss. Rohini Zade et.al [3] capillary tube of different diameter used to control the temperature and pressure in the refrigeration unit .results are plotted on the graph by using the capillary tube of different diameter with different load condition and conclusion are drawn showing the effect of coefficient of performance (cop). The objective of the study was to compare the refrigeration performance of different capillary tube diameters with different load conditions. The present work is focused on the influence of tube diameter on mass flow rate of refrigerant through helical coil capillary tube and also on investigation about the Coefficient of Performance (COP) of the system due to coiling effect of capillary tube.

Zhaohua Li et.al [4] In this research paper a comparative study on energy efficiency of R600a, R717, R 1234 and R134a in domestic refrigerator using in oil-free linear compressor. In this experiment the test rig consist with two similar linear compressor,

an evaporator with electric heater and an off-the-shelf water-cooled coaxial condenser. Various operation are performed in the test rig and the result show that the R717 (ammonia) has the highest cooling capacity, power input, resonant frequency while R600a (iso butane) has the lowest, and R1234yf has identical mass flow rate, saturation pressure, power input and resonant frequency of R134a which could be regarded as an ideal drop-in alternative to R134a with minor changes for an existing refrigerator and a slight efficiency drop.

Muhammad Tauseef Nasir et.al [5] The objective was to locate the most reasonable blend of working liquids considering R245fa, R600, R600a and R134a as refrigerants for ORCVCC framework trading heat with water as heat source. Subsequently, multi-target advancement was led to decide ideal working conditions by amplifying the second law productivity and limiting the estimation of the UAtot. At the outdoor temperature of 30 °C, R245fa ORC-R600a VCC was the best mix while at 35 °C and 40 °C, R600a ORC-R245fa VCC rules. Technique for order of preference by similarity to ideal solution (TOPSIS) was utilized to pick the ideal structure arrangement from Pareto front. In general, the ideal answer for heat source at 95 °C showed most elevated decrease in UAtot up to 37% in a roundabout way lessening the framework by and large expense while forcing the sentence of under 10% in second law efficiency compared to the maximum value.

Mert Tosuna Bahadır Doğanb M. et.al [6]: This trial study is completed on a commercial household refrigerator in a climatic chamber regarding IEC standards. During the trials, two sorts of smaller than usual channel condensers have been dissected with five diverse capillary lengths and five varying coolant sums so as to locate the best blend for better execution. The results of the investigation discharge the limits for either capillary length or refrigerant amount, which are 3.25 m and 50 g, As an outcome of the analyses, the common association of the refrigerant charge amount and the capillary cylinder length on the vitality utilization of the ordinary fridges are introduced for the two kinds of smaller than usual channel heat exchangers.

Pravin Jadhav & Neeraj et.al [7] , In this manuscript author focus on the flow characterization of the simple straight and spiral capillary tube of a carbon dioxide (CO2) and R22 refrigerants are statistically investigated. Here a homogenous one dimensional steady state adiabatic flow model is created using basic principles of thermodynamics and fluid dynamics. Churchill and Ju et al. employed friction factor correlations as well. The models are created using the energy, mass and momentum law of conservation equations. The impact of pitch of the spiral capillary cylinder on refrigerant mass flow rate is examined. A decrease in a mass flow rate by 22% and 15% of the spiral cylinder is seen with CO2 and R22 refrigerant, individually.

Liu Zhang et.al [8]: In this study analysis the mixture of refrigerant combing HFCs/HCs are better substitute to decrease the flammability of HCs while lowering the GWP of HFC. In this paper four types of HCFs/HCs mixture of refrigerants which is (R290/R134a, --R600a/R134a, and R1270/134a) with different compositions are investigated in vapor compression heat pump cycle. The effect of HCs refrigerant fraction on the mixture properties, including saturated liquid line, critical temperature, latent heat, critical pressure, and isotropic behavior are comparatively a analyzed. thermodynamic model is installed of heat pump simulation. For each R134a/HCs mixtures both the heating and cooling coefficient of performance normally first decrease and increase with the HCs mass friction.

Mohd Hazwan Yusof1, Sulaiman Mohd Muslim et.al [9] : The present work emphasizes on determining the performance of the air conditioner over a variation of outdoor temperatures. As recently featured, since the examination work was not led as per the ARI 210/240 norm, the outcomes couldn't be contrasted straightforwardly with the maker's information and past works by experts. However, it provides information on how the system performs and react with outdoor temperature variations. The conclusions are as follows: The condenser performance of the air conditioner maxed at lowest outdoor temperature, To = 30°C. The total cooling capacity (CT) and COP dropped with the increase in the outdoor temperature. As the outdoor temperature increased from 30°C to 36°C, the CT and COP dropped by 3.7% and 10.9% respectively.

Azridjal Aziz1 et.al [10]: The effect of cooling load on the performance of R22 RSAC when retrofitting with HCR22 as the working fluid in the standard condition has been conducted. The outcomes illustration evidence that the COP of RSAC surge with the growing cooling load, on the other hand the COP with HCR22 rise 16.10%, 12.66%, 16.56% and 19.99% greater than R22 for the cooling load of 0 W, 1000 W, 2000 W and 3000 W, respectively. The power consumption of compressor were censored with HCR22 which is lower than that of R22 by around 18.27%, 20.01%, 16.26% and 22.56% for different cooling load of 0 W, 1000 W, 2000 W and 3000W while the cooling of HCR-22 R-22 was Increasing the COP (%) Cooling Load capacity as well as the heat rejection capacity is maintained almost equal to that of the R22just slightly lower in value.

Adrián Mota-Babilonia et.al [11] In this research paper reduction in GHG emissions is a priority for stopping climate change. Such a decrease can be accomplished through an expansion in the energy efficiency and lessening the measure of refrigerant utilized in cooling frameworks, along these lines legitimately affecting the GWP. R32, with a GWP of 677, is being considered as an option to R410A (GWP of 1924) in cooling apparatuses in Europe and the USA. The present status of refrigerant R32 has been introduced in this work, and the principle ends are as per the following. The thermodynamic properties of R32 are very much characterized, and current examinations have concentrated on characterizing the most exact blend properties reachable. R32 is less combustible than hydrocarbons, and the measure of refrigerant permitted is adequate to be utilized in RACs.

Sharmas ValiShaika, T.P. Ashok Babub et.al [12] The paper present theoretical examination of several alternative refrigerants of R22. In this paper alternative refrigerant blend of R1270,R290,R134a,R32,R170 at various composition are considered. All the refrigerants possess low GWP and zero ODP compared to R22. The main objective of these work is to calculate thermodynamic performance of standard vapour compression refrigeration cycle (SVRC) with R22 and its alternative refrigerants. A MATLAB programming language code is evolved to itemize the thermodynamic performance of all the considered refrigerant. Thermodynamic analysis of the refrigerants are rated at the condensing temperature 54.4°C and evaporating temperature 7.2°C. the result show that coefficient of performance for the refrigerant mixture Re170/R1270/R134a(7.5/37.5/55 by % of mass) is 5.35% higher between the R22,R470C and four refrigerant. In this paper is about the different evaporating temperature by keeping condenser temperature as constant.

K.Harby et.al [13] The utilization of hydrocarbons offers a great drop-in substitute for the current halogenated refrigerants regarding natural effects and vitality utilization. In this examination, an audit of the past investigations did with hydrocarbons as elective refrigerants in refrigeration, cooling and heat pump, here vehicle cooling frameworks is also introduced and the results demonstrated that regardless of profoundly combustible qualities, hydrocarbons can offer legitimate options to the halogenated refrigerants from the point of view of condition sway, energy effectiveness, COP, refrigerant mass, and compressor discharge temperatures Guide on the future work needs in this field is introduced. At long last, a synopsis of past examinations and

techniques on unadulterated HC, HC blends, and HC/HFC mixes utilized for various applications has been introduced and talked about in detail.

Santosh kumar dubba, et.al [14] : In this paper discuss the flow characteristic of refrigerant over the diabetic and adiabatic capillary tubes to other geometries like coiled and straight. The summary of this paper the efficient techniques revealed in literature to increase the overall performance of a capillary tube based refrigeration system. The examine the flow characteristic of HCFC/HFRC/CFC refrigerants, their blends inside the capillary tubes. The transcritical R-744 is efficient with capillary tube for heat pump or refrigeration system. This paper the flow characteristic of refrigerants over adiabatic and diabetic capillary of different geometries and predict the number of model and its flow behaviors in a different capillary tubes have been prepared based on homogenous flow assumption.

Buddha Chouhan, et.al [15] : capillary tubes are used as expansion device in low capacity refrigeration machines like domestic refrigerators and window type air conditioners. The advantages of the capillary tube over other expansion devices are simple, inexpensive and cause compressor to start at low torque as the pressure across the capillary tube equalize during the off-cycle. The flow characteristics of refrigerants through capillary tubes have been studied extensively in past six decades, both experimentally and analytically, most of these studies mainly focused on straight capillary tubes.

Sunil M. Telang, et.al [16]: The design of capillary tube plays a very important role in the performance of a vapour compression refrigeration system. The study of the expansion device in simple vapor compression refrigeration system is necessary in order to understand the parameters which can enhance the overall performance of system. The experimental study was done on the capillary tubes of different length 3 feet, 3.5 feet, 4 feet each test section was studied with three distinct configurations i.e. helical coiled, straight coiled and serpentine coiled configuration. The diameter of each test section was kept constant to 0.036 inch.

4. OBJECTIVES

In this research paper we mainly focus on the experimental and comparative analysis along with the study on different capillary diameters and refrigerants in air conditioning test rig. The main objectives that to be studied in this work is:

1. To enhance the efficiency of vapor compression refrigeration system by using different refrigerants.
2. To enhance the coefficient of performance of the vapor compression refrigeration system.
3. To decrease the power consumption of the compressor and power consumption of condenser fan/compressor fans/ evaporator fan with the help of vapor compression refrigeration system.
4. To study the mass flow rate of fluid through the various geometry of the capillary tube at different blend of refrigerants.
5. To measure the vapor compression refrigeration system temperature and calculate the inlet and outlet side of air conditioning duct for calculating the refrigerating effect.
6. Enhance the power and reduce the input cost of the system.
7. In this system decreases the pollution in atmosphere and harm full effect in human body.

5. EXPECTED OUTCOME

In this paper, a thorough examination is vapour compression refrigeration system (VCRS), on reviewing various papers based on internal grooving, different size capillary tube, refrigerants and enhance the coefficient of performance in vapour compression refrigeration system

1. Many researchers point out the vapour compression refrigeration system (VCRS) hence a lot of work has been carried out on (VCRS) based capillary tube, refrigerants which become very common topic for experimental as well as simulation based study and this concept get remarkable results as well.
2. However in latest literature available of VCRS a new concept of varying different size capillary tube, refrigerants and enhance the coefficient of performance is also introduced but it need further research. From the reference of 10 International Journal on VCRS,
3. We understand the common research area of vapour compression refrigeration system (VCRS) and also find a research gap in the internal spiral grooving with different size capillary tube, refrigerants. But very few researcher works on varying coefficient of performance,
4. One of the latest paper focused on it but for external grooving hence there is a huge scope of research work on varying vapour compression refrigeration system (VCRS), hence this area of research motivate us to carry out our research further.

REFERENCE:

1. S.K.gugulothu, “Enhancement of household refrigerator energy efficiency by studying the effect of refrigerant charge and capillary tube length” and “Refrigeration books” vol. 7, No. 5, pp, 1121-1129, July 2021.
2. y. chandrasekhar yadav, “the effect of capillary tube length on the performance of vapour compression refrigeration system” vol. 13, issue 1, issn no: 0898-3577, July 2022.
3. miss. rohini zade et. al [3] the “experimental investigation on the performance of v.c.r. system using refrigerants ” volume: 06 issue: 07/ July 2019.
4. ZhaohuaLi, “Comparative study on energy efficiency of low GWP refrigerants in domestic refrigerators with capacity modulation”, Energy and Buildings, vol. 192, pp: 93-100, 1 June 2019,
5. Muhammad Tauseef Nasir, “Performance assessment and multi objective optimization of an Organic Rankin Cycle driven cooling air conditioning system”, Energy and Buildings, vol. 191, pp: 13-30 15 May 2019.
6. Mert Tosun BahadırDoğan M. MeteÖztürk L. BerrinErbay, “Integration of a mini-channel condenser into a household refrigerator with regard to accurate capillary tube length and refrigerant amount”, international Journal of Refrigeration, vol. 98, pp 428-435 February 2019.
7. Pravin Jadhav & Neeraj Agrawal, “A comparative study in the straight and a spiral adiabatic capillary tube”, International Journal of ambient Energy, issue 7, vol. 40, pp 693-698, 2019.
8. Liu Zhang “Cycle performance evaluation of various R134a/hydrocarbon blend refrigerants applied in vaporcompression heat pumps”, Advance in Mechanical Engineering, vol. 11(1) pp 1–14, 2019

9. Mohd Hazwan Yusof , Sulaiman Mohd Muslim "The Effect of Outdoor Temperature on the Performance of a Split-Unit Type Air Conditioner Using R22 Refrigerant", MATEC Web of Conferences, Volume 225, November 2018.
10. Azridjal Aziz1, "Effect of Cooling Load on the Performance of R22 Residential Split Air Conditioner when Retrofitted with Hydrocarbon Refrigerant (HCR22)", Journal of Advanced Research in Fluid Mechanics and Thermal Sciences, issue 1 vol.48,pp 100-108, 2018.
11. AdriánMota-Babiloni, "Refrigerant R32 as lower GWP working fluid in residential air conditioning systems in Europe and the USA", Renewable and Sustainable Energy Reviews vol. 80, pp 1031-1042, December 2017.
12. Sharmas ValiShaika, T.P. AshokBabub, "Theoretical Computation of Performance of Sustainable Energy Efficient R22 Alternatives for Residential Air Conditioners", International Conference on Alternative Energy in Developing Countries and Emerging Economies, vol. 138, pages 710-716, October 2017.
13. K.Harby, "Hydrocarbons and their mixtures as alternatives to environmental unfriendly halogenated refrigerants: An updated overview", Renewable and Sustainable Energy Reviews vol. 73, Pages 1247-1264, June 2017.
14 Santosh kumar dubba, "Flow of refrigerants through capillary tubes: A state-of-the-art", Experimental Thermal and Fluid Science, vol. 81, pp 370-381, February 2017.
15. Buddha Chouhan, Poshal, Suresh Kumar, "Analytical Investigation of R134a Flowing Through Adiabatic Helically Coiled Capillary Tubes" SO 3297:2007 Certified Vol. 4, Issue 2, February 2017.
16. Sunil M. Telang," An Experimental Study of the Effect of Capillary tube in Different Length and Different Configuration on the Performance of Simple Vapor Compression Refrigeration System" Volume: 06 Issue: 07 | July 2019.

International Research Journal
IJNRD
Research Through Innovation