PERFORMANCE ANALYSIS OF A RENOVATED MINI REFRIGERATOR

A Thesis
By

Douglas Rozario	ME2101023191
Md Farid Hossain	ME2101023187
Md Nasirul Islam	ME2101023454
Abu Sayed	ME2101023033



Department of Mechanical Engineering
SONARGAON UNIVERSITY (SU)

SEPTEMBER 2024

PERFORMANCE ANALYSIS OF A RENOVATED MINI REFRIGERATOR

A Thesis
By

Douglas Rozario	ME2101023191
Md Farid Hossain	ME2101023187
Md Nasirul Islam	ME2101023454
Abu Sayed	ME2101023033

Supervisor: Niloy Sarkar
Assistant Professor

Submitted To the
DEPARTMENT OF MECHANICAL ENGINEERING
SONARGAON UNIVERSITY (SU)

In partial fulfillment of the requirements for the award of the degree
of
Bachelor of Science in Mechanical Engineering

SEPTEMBER 2024

APPROVAL

This is to certify that the project "**Performance Analysis of a Renovated Mini Refrigerator'',** By Abu Sayed, ID: BME- 2101023033; Md Nasirul Islam, ID: BME2101023454; Douglas Rozario, ID: BME 2101023191, Md Farid Hossain, ID: BME2101023187; has been carried out under our supervision. The project has been carried out in partical fulfillment of the requirements of the degree of Bachelor of Science (B.Sc.) in Mechanical Engineering of years of 2024 and has been approved as to its style and contents.

Signature of the Supervisor

Niloy Sarkar
Assistant Professor
Department of Mechanical Engineering
Sonargaon University (SU)

DECLARATION

We, hereby, declare that the work presented in this project is the outcome of the investigation and research work performed by us under the supervision of **Niloy Sarkar,** Assistant Professor Department of Mechanical Engineering, Sonargaon University (SU). We also declare that no part of this project and thesis has been or is being submitted elsewhere for the award of any degree.

Douglas Rozario
ME 2101023191

Md Farid Hossain
ME2101023187

Md Nasirul Islam
ME2101023454

Abu Sayed
ME2101023033

ACKNOWLEDGMENT

We would like to our perform gratitude and respect our to our Supervisor ***Niloy Sarkar***, Assistant Professor, Department of Mechanical Engineering, Sonargaon Uniersity for introducing us to the fascinating topic of **Performance Analysis of a Renovated Mini Refrigerator**. And also thanks to our honorable sir **Prof. Md. Mostofa Hossain,** Head of Mechanical Engineering, Sonargaon University for introducing, suggesting and co-operating with us the topic of this thesis. They shared their knowledge and experience with us in analyzing this topic and evaluated our knowledge to synthesize those topics. We shall be grateful to them forever for his careful Supervision, valuable advice constructive criticism and continuous inspiration throughout the course of our thesis work.

ABSTRACT

In day to day life because of the rising temperatures there is a high demand for cooling systems. The project is based on an abstract of creating a cooling system which is a refrigerator system embedded with a cooling chamber. The current project is portable model which has the main functioning component as the air conditioner and the secondary component as the cooling chamber which acts as a refrigerator. Refrigerators are considered to be an important household item that falls under the category of cooling appliances. The basic structure of the refrigerator consists of a thermally insulated compartment which through a proper mechanism lowers down the temperature inside it and transfers the heat from inside to the external environment. As it keeps the temperature lower so it is used to keep and store the food items which can be spoiled at ambient temperature. Refrigerators in almost all the sizes are available at the market but they are restricted and limited for indoor usage only as they require electricity and are large. But presently, people are more inclined towards outdoor activities and they need to have a refrigerator to keep the essential items saved from spoilage and wastage.

The coefficient of performance is (COP) = 32.66667

TABLE OF CONTENTS

		Page No
Approval		-----iii
Declaration		-----iv
Acknowledgement		-----v
Abstract		-----vi
Table of Contents		-----vii
List of Figures		-----viii
List of Tables		-----viii
Chapter 1:	**Introduction**	
	1.1: Introduction	-----1
	1.2: Objectives	-----2
	1.3: Structure of the Project	-----2
Chapter 2	**Literature Review**	
	2.1: What is Refrigeration	-----3
	2.2: Literature Survey	-----3
Chapter 3	**Methodology**	
	3.1: Methodology	-----7
	3.2: Block Diagram	-----7
	3.3: Working Principle	-----8
	3.4: Schematic Diagram	-----8
	3.5: Hardware Implemantation	-----8
	3.6: Cpomplete Project Prototype	-----9
	3.7: New refrigerator	-----10
Chapter 4	**Hardware Implementation**	
	4.1: Introduction	-----11
	4.2: Compressor	-----12
	4.3: R410 Refrigerant	-----13
	4.4: Evaporators	-----14
	4.5: Condenser	-----15
Chapter 5	**Result and Discussion**	
	5.1: Result	-----19
	5.2: Advantage	-----21
	5.3: Application	-----21

Chapter 6 Conclusion and Future Work

6.1: Conclusion -----22
6.2: Future Work -----22
References -----23

List of Figures

Page No

Fig: 3.1 Block Diagram ----- 7
Fig: 3.2 Schematic Diagram of our System ----- 8
Fig: 3.3 Our Project Prototype ----- 9
Fig: 4.1 Compressor ----- 11
Fig: 4.2 Bare Tube Evaporator ----- 14
Fig: 4.3 Plate Evaporator ----- 15
Fig: 4.4 Finned Tube Evaporator ----- 16
Fig: 4.5 Condenser ----- 17
Fig: 5.1 Temperature Change graph ----- 18

List of Tables

Page No

Table: 5.1 Temperature Change Chart ----- 18

Chapter 1

Introduction

1.1 Introduction

Refrigeration systems are one of the most important products in contemporary world. They are vital in creating comfort living conditions. With the effect of global warming temperatures are rising, as a result refrigeration sales are increasing drastically every year. Various types of refrigerator systems are available in the market to cater the needs of different levels of refrigerator for homes, offices, industries, shopping malls etc.

Due to the huge demand of electricity over the world, we think of recovering the energy which is already spent but not being utilized further, to overcome this crisis with less investment. The climatic change and global warming demand accessible and affordable cooling systems in the form of refrigerators and air conditioners. Hence forth, we suggest Cost Free Cooling Systems. LPG is stored in liquefied state in cylinder before its utilization as fuel. According to the energy survey, the refrigerator is one of the heaviest power consumers amongst household appliances. It works on the principle that the expansion of LPG will be takes place during the conversion of liquid LPG into gaseous form. As a result of this, LPG gas pressure drops and the volume of gas will be increase this will be result into dropped in temperature of gas and it acts as refrigerant.

According to second law of thermodynamics, this process of cooling can only be performed with the aid of some external work. Hence, the power supply is regularly required to drive a refrigerator. The substance which works in a refrigerator to extract heat from a cold body and to deliver it to a hot body i.e.to surrounding is called refrigerant. Globally 17500 metric tons of conventional refrigerants is consumed by domestic refrigeration like CFC, HFC which causes high depletion if ozone layer (ODP) and Global Warming Potential (GWP). The use of LPG instead of CFC 22 has made a better progress since it has an environment friendly orientation with no ODP. Good product efficiency is resulted by the use of LPG because of its characteristics. It

indicates LPG can be used as an alternative refrigerant to CFC 22 after performing the test on new system.

1.2: Objectives

The objectives of this project are:

- To study about **Performance Analysis of a Renovated Mini Refrigerator.**
- To renovate a mini Refrigerator system.
- To test the performance of the renovated refrigeration system.
- Point out why are they very important for buildings.
- Describe vapor compression cycle basics.
- Draw cycle on T-S diagrams.
- Compare real cycles to ideal cycles.

1.3 Structure of the Project

This project book consists of five chapter. The first chapter contains the statement of the introduction, our background study for the project, Literature Review, objectives of the study in the project, Methodology and the project organization. Chapter two contains System design and simulation. Here we describe the design of this project, block diagram and circuit diagram, working principle, background and real project, details of component and instrument details of the whole project. Chapter three contains the Hardware implementation. Chapter four deals with the experiment result, calculation, advantages and application of this project. In the final chapter, we discuss about future scope and conclusion of our project.

Chapter 2

Literature Review

2.1 What is Refrigeration?

Refrigeration is defined as the process of removing heat from a body or enclosed space so that the temperature first lowered and then maintained at level below the temperature of surrounding. The equipment used to maintain the required temperature is called refrigerating equipment.

Types of Refrigeration system:

There are two types of refrigeration system

1. Vapour Compression Refrigeration system (VCRS)
2. Vapour Absorption Refrigeration system (VARS)

2.2 Literature Survey

Generally, refrigeration is the most reliable method of getting the right temperature for keeping the perishable things fresh and cool hence saved from getting spoiled and bacterial growth. A refrigerator does this by lowering down the temperature as compared to the ambient temperature. A refrigerator falls under the category of cooling appliances which works on two basic laws of physics: first, the flow of heat goes from the warmer material to cooler material only, and second, when the pressure of gas decreases, the temperature also decreases. Back before 1748, when there were no refrigerators, icehouses were used to provide cool storage for food and other items.

Then, in 1748, William Cullen at the University of Glasgow, Scotland demonstrated the first-everartificial refrigerator which was later designed by Oliver Evans in 1895 which was further developed by James Harrison in 1857 which was based on the vapor compression concept which is still used in all the refrigerators.

The main components and parts of a refrigerator include a compressor, capillary tube which is an expansion valve, condenser, and an evaporator. The compressor works like a pump and increases the pressure of the liquid inside the refrigerator through pulling in the air whereas the capillary tube meters the refrigerant flow from the condenser to the evaporator. The condenser diffuses the heat which is extracted from the interior of the system and the evaporator works to keep the inside cool as a result of the vapor compression process. Through a complete circuit, these parts are joint, and evaporation of liquid takes place which helps in achieving the lower temperature inside the refrigerator.

Refrigerators in almost all the sizes are available at the market but they are restricted and limited for indoor usage only as they require electricity and are large. But presently, people are more inclined towards outdoor activities and they need to have a refrigerator to keep the essential items saved from spoilage and wastage. So, this project focuses on designing, constructing, and 13 fabricating a mini refrigerator that would be powered through the batteries and is portable which can be easily used outdoors as well.

Franck Lucasa, Pascal Ortegaa, Mathieu Davidb, Frantz Sinamab, Boris Brangeonb Fabien Picgirardc, ICAE2015[4]:A method to evaluate energy performance of buildings cooled by room air conditioners. Because of their low cost, small air conditioning systems (AC) like split air conditioning systems are often installed without a proper study of building envelope performance. Furthermore, these systems are sometimes installed by tradesmen who neglect to comply with the appropriate rules and regulations. Finally, when routine maintenance is not rigorously carried out, the energetic performance of the system is compromised over time.

This article presents a practical, global approach to diagnose the performance of existing small air-conditioning installations in buildings applied in Reunion Island. This tropical Island aspires to become electricity self-sufficient.. This approach relies on a numerical tool and dynamic simulations of buildings equipped with AC. The simulations, which take account of the building envelope, a description of the system as well as the practices of the users, are based on the kernel calculation Energy. They

also take into account the climatic conditions and provide an estimate of the annual electricity consumption related to the cooling of the zone. This global analysis helps to qualify the entire system by assigning an energy label.

- *Buildings account* for over 42% of consumption of final energy [1] in France and between 20 and 40% in other developed countries. Perez Lombard [2] reports that the share of HVAC system for heating ventilation and air conditioning has now become the largest energy end use in the residential and non-residential sector. Wong [4] estimates that its represents one third of the total energy consumption for residential housings in Hong Kong.

- *Improving the design of buildings* and of the AC systems in order to reduce cooling loads is the subject of a great deal of research in southern hemisphere tropical climates. A large body of expertise has evolved, especially in respect to French overseas departments, like Reunion Island. As a result of this work, specific recommendations to design buildings adapted to the tropical climate have been established.

Jadhav T. S., Lele M.M., Engineering Science and Technology, an International Journal 18, 2015[5]: Theoretical energy saving analysis of air conditioning system using heat pipe heat exchanger for Indian climatic zones. Heat pipe heat exchanger (HPHX) is an excellent device used for heat recovery in air conditioning systems. The Energy Conservation Building Code (ECBC) e Bureau of Energy Efficiency (BEE) India classifies Indian climatic zones into five categories viz., Hot and Dry , Warm and Humid ,Composite, Cold and Temperate. From the paper we can say that indicated that very limited information is available on annual energy saving analysis of air conditioning system with HPHX for Indian climatic zones. The paper investigates the possible energy savings using HPHX for heat recovery in air conditioning system for Indian climatic zones. This paper discusses the use of HPHX only for the heat recovery application i.e., exchange of sensible heat between fresh outdoor air and conditioned return air. The maximum energy saving potential is revealed for hot and dry, warm and humid and composite Indian climatic zones.

- *In the last six decades*, India's energy use has increased 16 times and the installed electricity capacity by 84 times. In 2008, India's energy use was the fifth highest in the world. The air conditioning contributes towards significant energy usage of a building. The building sector represents about 33% of electricity consumption in India, with commercial sector and residential sector accounting for 8% and 25% respectively.

- *The Energy Conservation* Building Code (ECBC) e Bureau of Energy Efficiency (BEE) India[2] classifies Indian climatic zones into five categories viz., Hot and Dry (e.g. Ahmadabad, Jodhpur etc), Warm and Humid (e.g. Mumbai, Chennai etc), Composite (e.g. Nagpur, Jaipur etc), Cold (e.g. Guwahati etc) and Temperate (e.g. Bangalore etc).

Chapter 3

Methodology

3.1 Methodology

Our methodology for the project:

- Creating an idea for a **Renovated Mini Refrigerator,** And drawing and listed of components/materials to know which components/materials need to construct it.
- Collecting the all components/materials construct the system.
- Finally, we constructed this system & checked it finally that working very well.

3.2 Block Diagram

In our project we have set up a **Renovated Mini Refrigerator System**. Here, in this system, we are use AC source for operate. Here we also use a Compressor, Condenser, evaporator, blower fan, chamber materials etc.

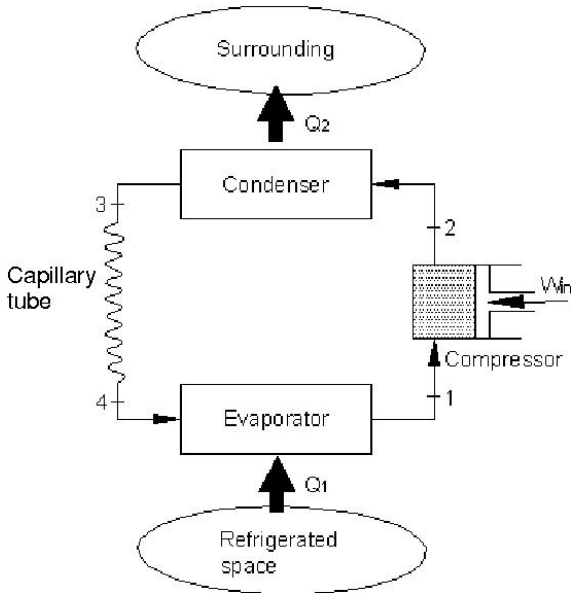


Figure 3.1: Block Diagram

3.3 Working Principle

Connecting with the power source here is AC 220 volts coming to the circuit. The compressor will come with a 220-volt controller unit. From the compressor through the gas condenser to the capillary tube the evaporator side will rotate in a circular motion. There will be gas in the compressor which will compress the compressor to the system. When the gas enters the condenser, it will remain heated. When the gas goes to the capillary tube , the gas cools and spreads its cold inner reside of room by a fan. We have used two types of gas in our system. Another compressor will work the same procedure with the different gas. Air will supply in the room and reduce the inside temperature through this air condition. Here our aim is to find out which gas is more efficient after the operation.

3.4 Schematic Diagram

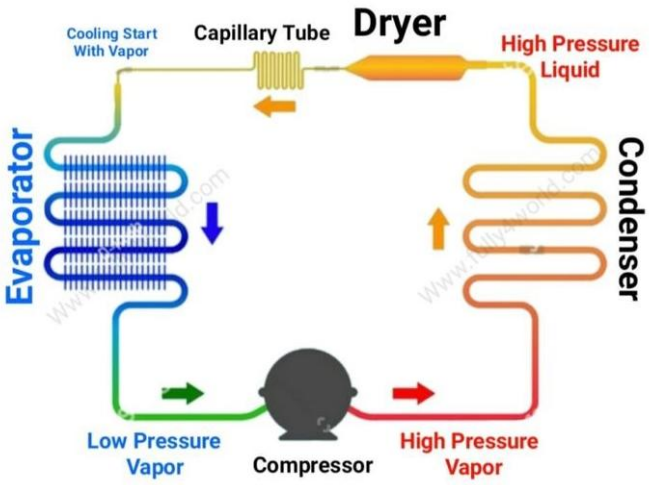


Figure 3.2: Schematic Diagram of our system

3.5 Hardware Implemantaion









3.6 Cpomplete Project Prototype

3.7 New Refrigerator



Figure 3.3: Our Project Prototype (Front View)

Chapter 4

Hardware Implementation

4.1 Introduction

Hardware is the most visible part of any information system. Here our hardware is Compressor, Coolant, Evaporator, Condenser, Expansion valve, chamber materials etc.

Hardware

1) Compressor
2) Evaporator
3) Condenser
4) Expansion valve

4.2 Compressor

A **compressor** is a mechanical device that increases the pressure of a gas by reducing its volume. An air compressor is a specific type of gas compressor. Compressors are similar to pumps: both increase the pressure on a fluid and both can transport the fluid through a pipe. As gases are compressible, the compressor also reduces the volume of a gas. Liquids are relatively incompressible; while some can be compressed, the main action of a pump is to pressurize and transport liquids.

Many compressors can be staged, that is, the fluid is compressed several times in steps or stages, to increase discharge pressure. Often, the second stage is physically smaller than the primary stage, to accommodate the already compressed gas without reducing its pressure. Each stage further compresses the gas and increases its pressure and also temperature (if inter cooling between stages is not used).

Mathematically the work done by the reciprocating compressor is equal to the work done by compressor **during compression** and discharge minus the work done during

the suction of fluid. p_2, v_2, T_2 are the corresponding pressure, volume, and temperature after compression.



Figure 4.1: Compressor

Use of Compressor

Air compressors have many uses, including: supplying **high-pressure clean air to fill gas cylinders**, supplying moderate-pressure clean air to a submerged surface supplied diver, supplying moderate-pressure clean air for driving some office and school building pneumatic HVAC control system valves, supplying a large

Use and Application

A compressor is a device that increases the pressure of a substance (usually a gas) by reducing the volume of the substance. Compressors are used in many applications, most of which involve increasing the pressure inside a gas storage container, such as:

- Compression of gases in petroleum refineries and chemical plants
- Storage of gas in high pressure cylinders
- Cabin pressurization in airplanes
- Air storage for underwater activities
- Filling tires

Other applications include, but are not limited to:

- Refrigeration and air conditioners

- Rail vehicle operation
- Gas turbines
- Powering pneumatic tools
- Pipeline transport of natural gas

4.3 R410 Refrigerant

R410 (**Iso-Butane**) is refrigerant grade Iso-Butane used as a replacement for R12 and R134a in a variety of high temperature refrigeration applications. ... It is the refrigerant of choice for domestic and light commercial refrigeration units, including fridges and freezers, drink dispensers and stand alone display units.

For the longest time, chlorofluorocarbons, hydrochlorofluorocarbons and hydrofluorocarbons have been used as refrigerants. Research, however, has shown that CFC, HCFCs, and HFCs are harmful to the environment. One of the biggest concerns has been the depletion of the ozone layer. Strides have been made (and are still continuing) to ensure that all refrigerants are safe, efficient, and above all, green. Most harmful refrigerants are being phased out and being replaced with eco-friendly refrigerants like R410.

Properties of R410A

Here are some of the top properties of R410 refrigerant.

- R410 is friendly to the environment – doesn't cause the greenhouse effect
- It has a low power consumption
- The refrigerant is compatible with different lubricants
- Its load temperature speed is low
- The cooling performance of R410 is very strong

Uses of R410A

As highlighted earlier, R410 has become the refrigerant of choice because of its eco-friendly properties. Let's look at some of the applications of this refrigerant.

- The refrigerant is used in geothermal power generation

- R410 is ideal for industrial refrigeration
- It's applicable in beverage dispensers
- It's used in dehumidifiers
- R410 can be used in plug-ins and vending machines
- They can also be used as feedstock in the petrochemical industry
- It's used in aerosol sprays

4.4 Evaporators

Introduction Evaporation and evaporation are two processes in which simultaneous heat and mass transfer process occurs resulting into separation of vapor from a solution. Evaporation and vaporization occur where molecules obtain enough energy to escape as vapor from a solution. The rate of escape of the surface molecules depends primarily upon the temperature of the liquid, the temperature of the surroundings, the pressure above the liquid, surface area and rate of heat propagation to product.

Working Principle of Evaporator and its Types

The function of evaporator is to absorb heat from surrounding location or medium which is to be cooled by means of refrigerant. The refrigerant either boils as it flows through a pipe, tube or other type of space so that liquid is continuously wetting all the inside surface or it boils in a shell around submerged tubes through which the fluid to be cooling is flowing. Various methods are used for evaporators, depending upon the refrigerant to be used and evaporator application, but iron, steel and copper predominate. Refrigerant evaporators should be of extended surface or finned tube type whatever practical. In order to keep the average surface temperature down, a good bond between the fin and tube is essential. Integral fins formed out of the tube itself are best in this respect and give the best heat transfer rate.

Type of evaporators based on operating condition:

1. Flooded type evaporator
2. Dry or direct expansion type evaporator

Type of evaporator based on construction:

1. Bare tube evaporator
2. Plate evaporator
3. Finned tube evaporator
4. Shell tube evaporator
5. Tube in tube evaporator

Bare tube evaporator:

The bare tube evaporators are made up of copper tubing or steel pipes. The copper tubing is used for small evaporators where the refrigerant other than ammonia is used while the steel pipes are used with the large evaporators that uses ammonia as refrigerants. The evaporator comprises of several turns of tubing and are usually used for liquid chilling. In blast cooling and freezing operations, atmospheric air flows over bare tube evaporator and the chilled air leaving it used for cooling purposes.

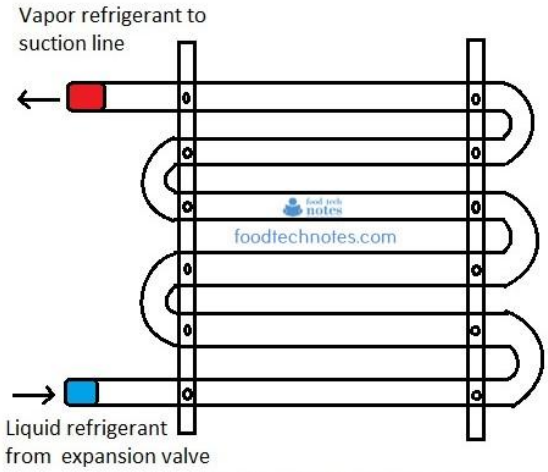


Figure 4.2: Bare Tube Evaporator

Plate evaporators: In plate type evaporators, the coil usually made of copper of aluminum is embedded in the plate so as to form a flat looking surface. Externally the plate type evaporator looks like single plate but inside it, there are several turns of the metal tubing through which the refrigerant flows.The advantage of plate type evaporator is that they are more rigid as the external plate provides lots of safety. The

external plate also helps increasing heat transfer from metal tubing to the substance to be chilled. These types of evaporators are easy to clean and can be manufactured cheaply. They can be converted into box shape, partitions or shelves as required for different purposes. Due to various advantage and flexibility offered by plate type evaporator, they are used extensively.

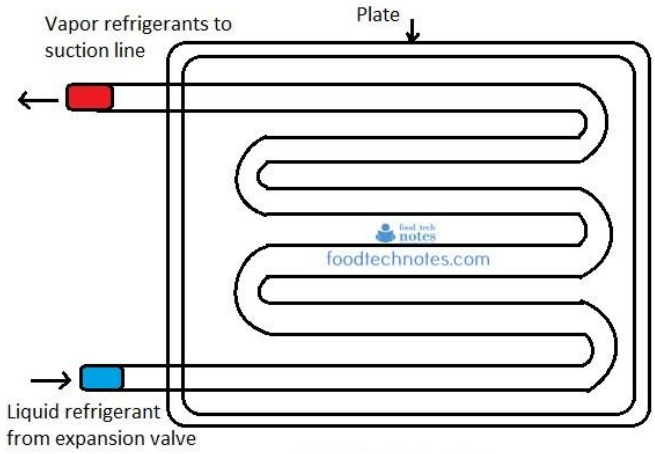


Figure 4.3: Plate Evaporator

Finned tube evaporator:

The finned evaporators are tube type evaporators covered with the fins. When the fluid (air or water) to be chilled flows over the bare tube evaporator, lots of cooling effect from the refrigerant goes wasted since there is less surface for transfer of heat from fluid to refrigerant. The fins on the finned tube evaporator increases contact surface area and increases heat transfer rate. Thus finned evaporators are more effective than bare tube evaporators.

For fins to be effective, it is very important that there is good contact between coil and the fins. In some cases fins are soldered directly to surface of the coil and in other cases, the fins are just slipped over the surface of tubes or coils. The finned evaporators are most commonly used in the air conditioners of almost all type like window, split, packaged and central air conditioning. In this system, finned evaporator is known as cooling coil.

The hot air flows over finned evaporator for cooling. To increase effectiveness of heat transfer from evaporator, the tubing are also given internal fins. These fins are made

by forming different internal cross section shapes at the time of manufacturing of tubing.

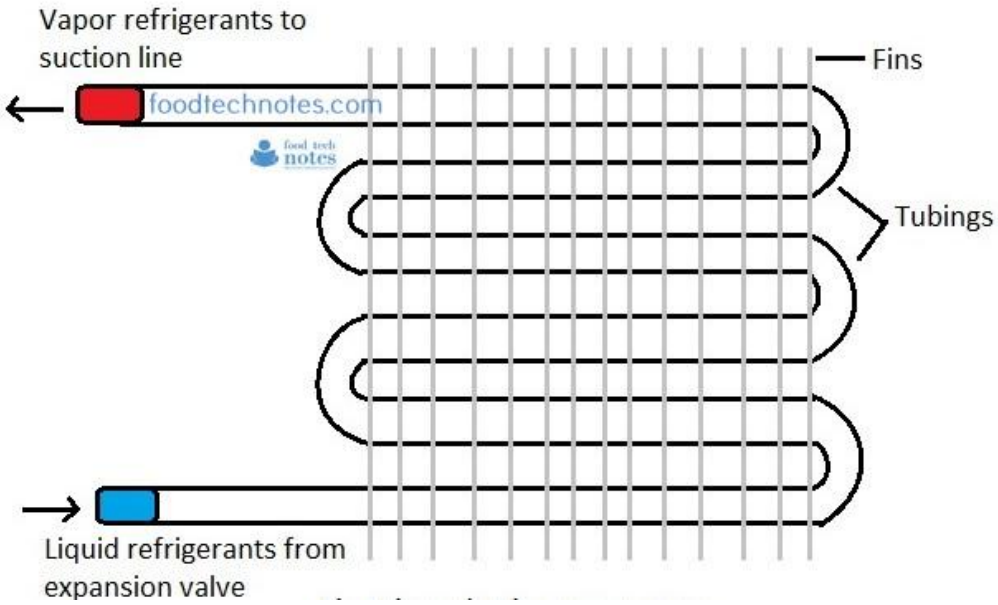


Figure 4.4: Finned Tube Evaporator

4.5 Condenser

In systems involving heat transfer, a **condenser** is a heat exchanger used to condense a gaseous substance into a liquid state through cooling. In so doing, the latent heat is released by the substance and transferred to the surrounding environment. Condensers are used for efficient heat rejection in many industrial systems. Condensers can be made according to numerous designs, and come in many sizes ranging from rather small (hand-held) to very large (industrial-scale units used in plant processes). For example, a refrigerator uses a condenser to get rid of heat extracted from the interior of the unit to the outside air. Condensers are used in air conditioning, industrial chemical processes such as distillation, steam power plants and other heat-exchange systems. Use of cooling water or surrounding air as the coolant is common in many condensers.

Principle of Operation

A condenser is designed to transfer heat from a working fluid (e.g. water in a steam power plant) to a secondary fluid or the surrounding air. The condenser relies on the efficient heat transfer that occurs during phase changes, in this case during

the condensation of a vapor into a liquid. The vapor typically enters the condenser at a temperature above that of the secondary fluid. As the vapor cools, it reaches the saturation temperature, condenses into liquid and releases large quantities of latent heat. As this process occurs along the condenser, the quantity of vapor decreases and the quantity of liquid increases; at the outlet of the condenser, only liquid remains. Some condenser designs contain an additional length to subcool this condensed liquid below the saturation temperature.

Countless variations exist in condenser design, with design variables including the working fluid, the secondary fluid, the geometry and the material. Common secondary fluids include water, air, refrigerants, or phase-change materials.

Condensers have two significant design advantages over other cooling technologies:

- Heat transfer by latent heat is much more efficient than heat transfer by sensible heat only
- The temperature of the working fluid stays relatively constant during condensation, which maximizes the temperature difference between the working and secondary fluid.

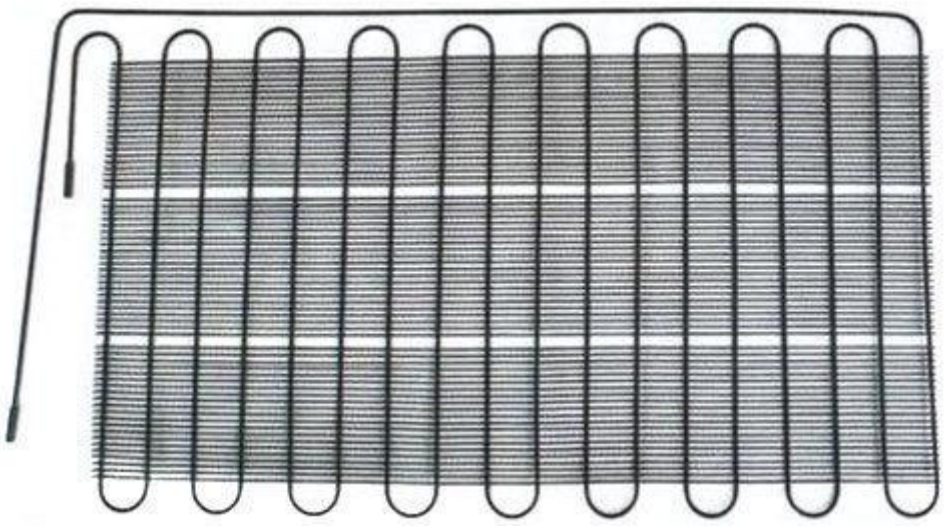


Figure 4.5: Condenser

Chapter 5

Result and Discussion

5.1 Result

After making our project we observe it very careful. It works as we desire. Our project give output perfectly and all equipment are work perfectly. We check how much it works and we get perfect output from this project.

- Finally, we have completed our project successfully & check our project its run accurately according to our objective.
- At first, we start our system and operate different condition.
- This system measures the temperature with the help of temperature sensor. And make temperature as need in this cooler cycle system.

COP=Qin/Work Done

=T2/T1-T2

Our System result

Table: 5.1: Temperature Change Chart

Serial No	Time	T (Hot)	T(Cold)
01	5 min	30℃	27℃
02	15 min	30℃	25℃
03	30 min	30℃	23℃
04	40 min	30℃	22℃
05	60 min	30℃	21℃

After 30 mins our comfort temperature is 22℃

Here, Our Comfort temperature COP is –

$$\text{COP} = \frac{T_{cold}}{T_{hot} - T_{cold}}$$

$$= \frac{(21+273)}{(30+273)-(21+273)} \text{ [we convert it Kelvin]}$$

$$= 32.666$$

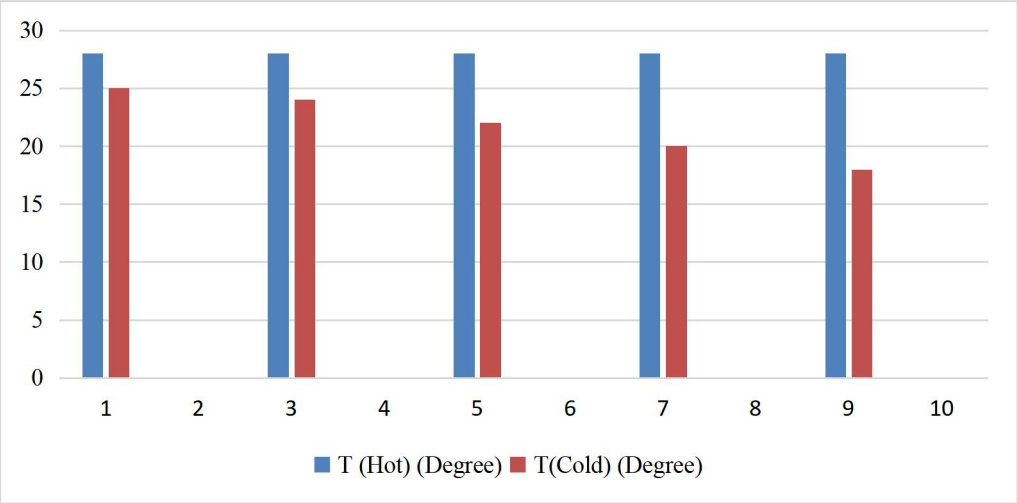
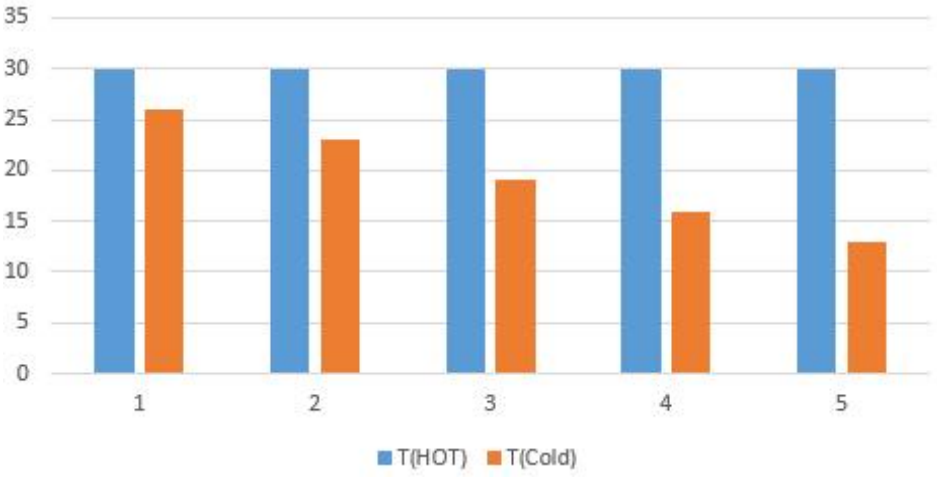


Figure: 5.1: Temperature Change Graph

New Refrigerator Result Analysis

Serial No	Time	T (Hot)	T(Cold)
01	5 min	30	26
02	15 min	30	23
03	30 min	30	19
04	40 min	30	16
05	60 min	30	13



5.2 Advantage

There are many advantages of our project because of its accuracy. Some of the advantages are pointed out below:

- Creates a comfortable and productive work environment.
- Energy-efficient cooling solution.
- Environmentally friendly.
- No Oil consumption.
- Less skill technicians is sufficient to operate.
- Installation is simplified very much.
- Simple construction
- Ease of operation.

5.3 Application

The application areas for this project in this modern and practical world are huge and some of these are given below:

- It can be used for Industrial work.
- It can be used in factories.
- It can be use for indoor purpose

Chapter 6

Conclusion and Future Work

5.1 Conclusion

- ✧ The refrigerant system satisfies the need of user at the most economical cost.
- ✧ The portable refrigerant system is having very low manufacturing and maintenance cost.
- ✧ It provides transportability, can be move anywhere easily.
- ✧ It is completely non-polluting. refrigerant system
- ✧ While working on the project, we learned many new things and developed the skills required to conduct research, practical work, and report writing.
- ✧ As a result of all these learnings, we became more confident in our field.
- ✧ The project of manufacturing a mini-refrigerator was very interesting to perform as we set the objectives which were quite realistic like we wanted to develop a refrigeration system that could be used to keep things cool while traveling or doing outdoor activities while keeping their size small and portable and we achieved this task.

5.2 Future Work

The model can be improved by making some changes in the hardware and components. Some suggestions are given below-

- We will increase its working accuracy level.
- We will change the refrigerator for different data.
- We will add a sensor and a display to measure and monitoring the cooling situation.

References:

[1] J.K..Jain and Hindoliya D.A, “Development and Testing of Regenerative Evaporative Cooler”, International Journal of Engineering Trends and Technology, Vol.3, No. 6, Pp 694-697,2012.

[2] M.P.Poonia, A.Bhardwaj, Upender Pandel and A.S.Jethoo A.S, “Design and Development of Energy Efficient Multi-Utility Desert Cooler”, Universal Journal of Environmental Research and Technology, Vol. 1 Pp 39-44, 2011.

[3] B.Chandrakant, Kothare and Nitin B. Borkar, “Modified Desert Cooler”, International Journal of Engineering and Technology, Vol.3, No.2, Pp 166-172, 2011.

[4] Ndukwu Macmanus Chinenye, “Development of Clay Evaporative Cooler for Fruits and Vegetables Preservation”, Agricultural Engineering International: CIGR Journal Manuscript No.1781. Vol. 13, No.1, Pp 1-8, 2011.

[5] Farhan A. Khmamas, “Improving the environmental cooling for air-coolers by using the indirect-cooling method”, ARPN Journal of Engineering and Applied Sciences, Vol. 5, No. 2, Pp 66-73, 2010.

[6] R.K.Kulkarni and S.P.S.Rajput, “Comparative performance of evaporative cooling pads of alternative materials”, International Journal of Advanced Engineering Sciences and Technologies, Vol.10, No. 2, Pp 239–244, 2011.

[7] Sirelkhatim K. Abbouda and Emad A. Almuhanna, “ Improvement of Evaporative Cooling System Efficiency in Greenhouses” International Journal of Latest Trends in Agriculture & Food Sciences, Vol. 2, No. 2, Pp 83-89, 2012.

[8] Hussain Yousif Mohammed and Abduljaleel Hussain Abd, “Optimum Design of Evaporative Air Cooler”, Journal of Kerbala University, Vol. 10, No.2, Pp 287- 299, 2011.

[9] S. Celik and E. C. Nsofor, “Performance analysis of a refrigerating system with a grooved-tube evaporator,” *Applied Thermal Engineering*, vol. 73, no. 1, pp. 745–750, 2014.

[10] A. Domanski, J. Choi, and W. Payne, “Longitudinal heat conduction in finned-tube evaporators,” in 22nd *IIR International Congress of Refrigeration*, Beijing, China, 2007.

[11] S. Joshi and M. S. K. Badholiya, “A review paper on experimental investigation of cold storage for cop with number of door opening,”

[12] H. Zhang, E. Wang, and B. Fan, “Heat transfer analysis of a evaporator for engine exhaust heat recovery*,” Energy Conversion and Management*, vol. 65, pp. 438–447, 2013.