DESIGN AND FABRICATION OF ENERGY EFFICIENT OF FROST AND NON FROST CHAMBER OF A REFRIGERATION WITH THE SAME COMPRESSOR AND CONDENSER.

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STUDENT DECLARATION

We do hereby solemnly declare that, the work presented here in this project report has been carried out by us and has not been previously submitted to any University Organization forward or any degree or certificate. We further undertake to indemnify the university against any loss or damage arising from b reach of the foregoing obligation.

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CERTIFICATE OF SUPERVISOR

This is to certify that the thesis work on Design and fabrication of energy efficient of frost and non frost chamber of a refrigeration with the same compressor and condenser. by md. Md. Musharaf Hussain-ME2003022229, under my supervision. The report or the information will not be used for any other purpose.

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ACKNOWLEDGEMENT

The report titled as on **"Design and fabrication of energy efficient of frost and non frost chamber of a refrigeration with the same compressor and condenser"** by been prepared to fulfill the requirement of our fracture program, In the process of preparing our practicum report, we would like to pay our gratitude to some persons for their enormous help and vast cooperation. At first we would like to show our gratitude to the University authority to permit us to do our practicum Specially, we thank to our honorable teacher Prof. Md. Mostofa Hossain Head to Departments Mechanical Engineering Sonargaon University (Su), for his valuable and patient advice, sympathetic assistance, co-operation, contribution for new idea. Deep theoretical and hardware knowledge & keen interest of our supervisor in this field influenced us to carry out this project his endless patience, scholarly guidance continual encouragement, constant and energetic supervision, constructive c criticism, valuable advice, reading many inferior drafts and correcting them at all stage have made it possible to complete this project

ABSTARCT

Refrigerators used in daily life are one of the indispensable tools. Uninterrupted power should be supplied to the refrigerators in order to maintain cooling service. Domestic refrigerator may be operating continuously to maintain proper food storage condition. The continuous operation of this equipment accounts more electrical consumption. A significant amount of waste heat is rejected by the condensers of refrigerator Although the given project has two chambers, with the help of a plressure valve, the gas flow should be stopped in one of the chambers and the gas flow should be opened in the other chamber by opening the pressure valve. To Start the frost phase chamber, the non frost timer switch should be dopt off. In this way, the same compressor and two chambers can be poerated by the same condenser.

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CHAPTER 1

INTRODUCTION

1.1 Background

In the early years of the twentieth century, the vapor absorption cycle using water-ammoniasystems was popular and widely used, but after the development of the vapor compressioncycle it lost much of its importance because of its low coefficient of performance (about onefifth of that of the vapor compression cycle). Nowadays, the vapor absorption cycle is usedonly where waste heat is available or where heat is derived from solar collectors. Absorptionrefrigerators are a popular alternative to regular compressor refrigerators where electricity isunreliable, costly, or unavailable, where noise from the compressor is problematic, or wheresurplus heat is available (e.g., from turbine exhausts or industrial processes, or from solar plants).Absorption cooling was invented by the French scientist Ferdinand Carré in 1858 (1). Theoriginal design used water and sulphuric acid. In 1922 Baltzar von Platen and Carl Munters,while they were still students at the Royal Institute of Technology in Stockholm, Sweden,enhanced the principle with a 3-fluid configuration (2). This "Platen-Munters" design canoperate without a pump. Commercial production began in 1923 by the newly formedcompany AB Arctic, which was bought by Electrolux in 1925. In the 1960s, the absorptionrefrigeration saw a renaissance due to the substantial demand for refrigerators for caravans(travel trailers). AB Electrolux established a subsidiary in the United States, named DometicSales Corporation. The company marketed refrigerators for RVs under the Dometic brand. In2001, Electrolux sold most of its leisure products line to the venture-capital company EQTwhich created Dometic as a stand-alone company. An absorption refrigerator is a refrigeratorthat uses a heat source (e.g., solar energy, a fossil-fueled flame, waste heat from factories, ordistrict heating systems) to provide the energy needed to drive the cooling process

1.2 Problem Identification

A refrigerator is an essential element in the preservation of perishable products; if there is some damage, its poorly performance prevents to guarantee the quality of the products contained in it, because the temperature and humidity conditions of the container are not the desired. In this work, we identify the essential processes and the most critical variables of the equipment, according to the sub-processes carried out in it. We propose a diagnosis path to establish the failures in the refrigerator, considering the most common faults mentioned in the literature. We present a failure identification process, described like a state machine which allows checking all the important elements of the equipment before to assure the presence of a failure, and in case of this, categorize according to the kind of failure and the possible component damaged. For simple interpretation of the equipment condition, we define a list of codes for the refrigerator, in order to ease the task of the technical staff.

You can tell an undercharging refrigeration system when:

- The compressor is running hot and the performance drops.
- There is also a drop in suction and discharge pressures.
- You may also notice vapor bubbles in the liquid sight glass.
- The condenser has suspiciously low readings.
- The compressor tests low ammeter readings.
- The cold rooms are warmer than usual.

1.3 motivation

The fundamental reason for having a refrigerator is to keep food clod. Cold temperatures help food stay fresh longer. The basic idea behind refrigeration is to slow down the activity of bacteria (which all food contains) so that it takes longer for the bacteria to spoil the food.

It has been proven that refrigeration of food at an optimum temperature plays a fundamental role in maintaining food safety. In many cases it is necessary to control and maintain the storage temperature, which will be different for each type of product.

In addition, if we lower the storage temperature of perishable foods, we will be able to significantly reduce the reproduction speed of the vast majority of microorganisms. These are the cause of decomposition, favouring the loss of product quality and generating possible illnesses in consumers.

Refrigeration slows down the metabolism of organic matter to a near standstill at -18°C (the international standard for most frozen products). At this temperature, the partial or total inhibition of altering processes in food, such as certain enzymatic reactions or the metabolic degradation of proteins, is achieved. This slows down the decomposition and spoilage of these foods, as well as preventing possible health problems after consumption.

1.4 Aim and objectives.

We have some specific objectives for this project and they are pointed below.

- To design fabrication of energy efficient of frost and non frost chamber of a refigeration with the same compressor and condencer.
- To taking notes from our real-time test.
- Loadshedding is high bye alternative method is to use frost chamber.
- keep food well for o long time .
- To improve sustainability and customer service.

1.5 Thesis Outline

- **Chapter 1: Introduction .**This Chapter is all about background study , problem identification ,motivation and aims and objectives.
- **Chapter 2:** Literature Review- Here briefly describe about floating solar panel project, its advantages, disadvantages, application and some live floating solar panel projec.
- **Chapter 3:** Research/Experimental design. This chapter is discussed about instrument and Hardware details and its working procedure andExperimental design .
- **Chapter** 4: The Design Method and Process- Here briefly discuss about project methodology, Block Diagram, circuit diagram, required instrument cost analysis, working principle, work plan, output curve analysis etc.
- **Chapter 5:**Conclusion- This chapter is all about our project advantages, limitation, application and this conculsion.

CHAPTER 2

LITERATURE REVIEW

2.1 Literature Survey

The idea of absorption cycle was developed back in 17th century when it comes to peoplemind that cooling effect may be produced by keeping pure water in the same containerhaving sulfuric acid. Sulfuric acid absorbs the high energy molecules evaporating from waterleaving behind water with a much less temperature. In 18th century (6), EdmondCarrédeveloped the first absorption refrigerator, heobserved the formation of an ice layer invessel having water when it was connected to another vessel containing H2 SO4 Corrosiveaction and leakage of environmental air into the vessel create some problems for this system.FerdinandCarre developed a unique refrigeration system for the application of making iceand food storage in in 1859 (7).He replaced sulfuric acid by using water/ammonia as theoperating fluid in his machine, where ammonia works as a refrigerant and water as absorbent.This continuous absorption refrigerator took out a patent in United State in 1860. The designdeveloped by him was a basic design in the early stages of refrigeration development.

In the 1950's, a system using lithium bromide/water as the working fluid was introduced.This system uses water as refrigerant and LiBr as an absorbent. COP of ofLiBr-water systemdeveloped was very low to improve it a modification to the system was done by introducing adouble-effect absorption system which uses the waste heat from a generator as a heat sourcefor another generator in the same system improving the system performance. It has been usedas an industrial standard for absorption refrigeration cycle.To use low grade energy for cooling purposes directly vapor absorption refrigeration is the best choice in comparison to the conventional vapor compression system which requireahigh grade energy. Absorption system doesn't involve any moving part except for a small pump which operates on a much less input power than a compressor of vapourcompressionsystem. Absorption refrigerator require some heat energy for separation of refrigerant fromabsorbent in the generator. The heat energy may be obtained from different sources such aswaste heat from engines, by burning fuels and solar energy etc. Different type of collectorssuch concentrating and flat plate solar collectors are used in an attempts to run vapourabsorption systems. Around 1950 several small solar absorption refrigeration systems have been made in different countries. Serious consideration to solar refrigeration systems wasgiven since 1965 due to the scarcity of fossil fuel based energy sources and depletion ofOzone layer by chlorofluorocarbon refrigerants (CFCs) used in vapourcompressionrefrigerator. About 500 solar absorption systems were reported in 1976 being used inUnited States (8).Most of these system were operated on a moderate temperature and wereusingLiBr-water as the working fluid.

V.K. Bajpai (9) designed an ammonia-water based solar vapour absorption refrigeration unit.For his design condition of Condenser pressure 10 bar, Evaporator pressure 1 bar and solarcollectors 24 square meter he finds out that COP of the whole system is 0.58. With the helpof the results he obtained he proved that a solar powered absorption refrigeration system isfeasible and reasonable to be used .

He proved that in the month of summers, solar potential isquite high, the unit can be used for refrigeration.

F. Assilzadeh, S.A. Kalogirou, Y. Ali, K. Sopian (10) simulate and optimize a LiBrsolar absorption cooling system with evacuated tube collector using

TRNSYS program.They optimize the system for a 3.5 kW using evacuated tubes solar collector of area 35 m2
making an angle of 200
with horizontal. They describe the advantage of solar-poweredsystem over other power sources by proving that the system is in phase with the daily solarradiation, i.e. the greater the sunshine , the larger the cooling effect achieved by the solarrefrigerating system. For a continuous operation of the generator and increase the reliabilityof the system, a hot water storage tank is essential for high quality performance.MS. AARTI RAJENDRA SAKHARE, PROF. SATISH G.

BAHALEYT (11) designed anammonia-water based solar powered vapor absorption refrigeration system using solarthermal collector for heating the refrigerant. They use Cylindrical parabolic concentratingcollector for heating the solution in generator.

For their design analysis the condenser andabsorber has to be maintained at temperature than 40, evaporator temperature has to be morethan 10 and the generator temperature must not exceed 85, in order to run the systemefficiently during the utilization of heat from sun and provide cooling effect.
describes the design of arefrigerator using LiBr as working fluid powered by solar energy. The solar energy is storedin DC battery which is then utilized by heating coil and pump. They obtained maximum COPand Relative COP from their data. From their calculation they conclude that COP increaseswith the increase in generator temperature and vice versa within the respective limits they proved that at various generator, condenser temperatures LiBr-water cycles give betterefficiency than ammonia-water cycle.

PongsidSrikhirin, Satha Aphornratana (6)
compare various types of absorptionrefrigeration systems for an improved performance of the system. They discuss various typeof absorption system from the conventional single effect refrigeration system, to double-effect, dual cycle absorption system, self-circulating system and many others. There studiesshow that COP of the system may be improved by an increase complexity of the conventionalsystem.

1. R. Cabello, E. Torrella and J. Navarro-Esbri [1], have analyzed the performance of a vapour compression refrigeration system using three different working fluids (R134a, R407c and R22). The operating variables are the evaporating pressure, condensing pressure and degree of superheating at the compressor inlet. They analyzed that the power consumption decreases when compression ratio increases with R22 thausing the other working fluids.
2. B.O. Bolaji et al[2] investigated experimentally the performances of three ozone friendly Hydrofluorocarbon (HFC) refrigerants R12, R152a and R134a. R152a refrigerant found as a drop in replacement for R134a in vapour compression system.B.O. Bolaji[3] discussed the process of selecting environmental-friendly refrigerants that have zero ozone depletion potential and low global warming potential. R23 and R32 from methane derivatives and R152a, R143a, R134a and R125 from ethane derivatives are the emerging refrigerants that are non toxic, have low flammability and environmental-friendly. These refrigerants need theoretical and experimental analysis to investigate their performance in the system.

3. James M. Calm [4], has studied the emission and environmental impacts of R11, R123, R134a due to leakage from centrifugal chiller system. He also investigated the total impact in form of TEWI and change in system efficiency or performance due to charge loss. He also summarized the methods to reduce the refrigerant losses by the system like design modifications, improvement in preventive maintenance techniques, use of purge system for refrigerant vapour recovery, servicing and lubricant in system.
4. Samira Benhadid-Dib and Ahmed Benzaoui [5], have showed that the uses refrigerants are harmful for environment and the use of "natural" refrigerants become possible solution Here natural refrigerants are used as an alternative solution to replace halogenated refrigerants. The solution to the environmental impacts of refrigerant gases by a gas which contains no chlorine no fluorine and does not reject any CO2emissions in the atmosphere. The researchers showed that emissions have bad effects on our environment. They also concerned by a contribution to the reduction of greenhouse gases and by the replacement of the polluting cooling fluids (HCFC).
5. Eric Granryd [6], has enlisted the different hydrocarbons as working medium in refrigeration system. He studied the different safety standards related to these refrigerants. He showed the properties of hydrocarbons (i.e. no ODP and negligible GWP) that make them interesting refrigerating alternatives for energy efficient and environmentally friendly. But safety precautions due to flammability must be seriously taken into account.
6. Satheshkumar GOVINDASAMY *1, Mylsamy KALIYANNAN2, Saravanan SADHASIVAM3, Rajaguru KADASARI4 [7] At the present scenario, the action of ensuing the philosophy of reducing energy consumption and saving it for longer period without drop off in performance is increased. On the other hand, global warming and ozone layer depletion become foremost challenges. These concerns are takes place in Thermal systems like refrigerator and air conditioning. To resolve the above challenges, the nano refrigerants are used in refrigeration, which has previously got the attention due to its distinctive properties such as thermal conductivity. They also have the potential to improve the heat transfer performance of refrigeration. This project interrogated on the performance of domestic refrigeration system using normal condenser and microchannel condenser with and without nanoparticles. The Cerium oxide and Zinc oxide nanoparticles in the size of about 20-30nm and 30-50nm respectively with R134a domestic refrigerant were used. The experimentation carried out using 2 gm ofCeO2and ZnO nanoparticles in three different ratios [0.5:1.5,1:1 and 1.5:0.5] with R134a refrigerant. Hereby, the result conquered that 33.3% increase in the Actual COP of domestic

refrigeration system using normal condenser with 1:1 ratio of nanoparticles when compared with the refrigeration system using microchannel

7. condenser with and without nanoparticles.

The impact of various nano particles concentration in the refrigerant/lubricants of vapour compression refrigeration and observed better exergy destruction results at 0.5% concentration without compromising the performance[23]. The impact of copper (II) oxide (CuO) and copper/silver (Cu/Ag) alloy nanoparticles with HFC-R134a refrigerant in domestic refrigerators. The tribological effects on compressor parts were analysed after including the nano additives into the system and COP was analysed as performance parameter. Nano additives stability was studied using thermos gravimetric analysis. Adding 0.5 vol. % of CuO and Cu/Ag nano particles in POE resulted in great impact over the tribological and performance of VCR. The values of COP during the examination revealed about 20.88% increase due to the incorporation of nano refrigerants. Also, the co-efficient of friction for the developed nano lubricant was observed to be 5.5% lesser than that of CuO lubricant and 9.9% lower than traditional pure lubricants available.

2.2 Summary

From the literature discussed above, we gained a lot of knowledge and we inspired to do this project .We were able to do it with everyone tireless work.

CHAPTER 3

RESEARCH/EXPERIMENTAL DESIGN

3. Required Component and Experimental

Design. Electrical System:

3.1. Refrigerator compressor.

3.2. Refrigerator fuse.

3.3. Overload & Relay Protector

3.4. Refrigerator Capacitor.

3.5. Fridge Thermostat.

3.6. Fridge Defrost Timer.

3.7. Refrigerator Defrost Heater.

3.8. Refrigerator Cooling Fan.

3.9. Fridge Door Switch.

3.10 Refrigerator Light.

Mechanical System

3.11. Refrigerator Cooling Compressor

3.12. Refrigerator Condenser.

3.13. Refrigerator Filter.

3.14. Freeze capolary

3.15. Refrigerator Evaporator.

3.16. High pressure Gas Cylinder valve

Specification

3.1. Refrigerator compressor.



3.1. Refrigerator compressor**.**

The compressor, similar to an engine, initiates the cooling process by pumping the refrigerant, or cooling agent, through the refrigerator. Increasing both pressure and

temperature, it propels the coolant along the refrigeration cycle. Positioned at the bottom or back of the refrigerator, the compressor acts as the system's central component, circulating refrigerant throughout.

3.2. Refrigerator Thermal



fig. 3.2. Refrigerator Thermal fuse.

A thermal fuse or thermal cutoff is a safety device which open circuits against overheat. It detects the heat caused by the over-current due to short circuit or component breakdown. Thermal fuses do not reset themselves when the temperature drops like a circuit breaker would. A thermal fuse must be replaced when it fails or is triggered.

Unlike electrical fuses or circuit breakers, thermal fuses only react to excessive temperature, not excessive current, unless the excessive current is sufficient to cause the thermal fuse itself to heat up to the trigger temperature.

3.3. Overload & Relay Protector



fig.3.3. Overload & Relay Protector

An overload relay is an electrical device used to protect an electric motor from overheating. So it is essential to have sufficient motor protection. An **electrical motor** can be operated safely with the help of overload relays, fuses otherwise circuit breakers. But this relay protects the motor whereas the circuit breaker otherwise fuse protects the circuit. More purposely, fuses, as well as circuit breakers, are intended to detect the overcurrent within the circuit, whereas the relay is intended to detect overheat if an electric motor gets heated. For instance, an overload relay can explore without the tripping of a CB (circuit breaker). One does not restore the other. This article discusses an overview of overload relay, types, and its working.

3.4. Refrigerator Capacitor.



fig. 3.4. Refrigerator Capacitor.

It is the run capacitor, which supplies the power to the compressor when the Post Temperature Coefficient (PTC) gets hot. This heat then turns on the capacitor, switching it on. Thus, the compressor gets into the action, cooling down the fridge.

Hence you see, it is the capacitor that supplies power to the compressor, which is the base of the fundamental functionality of a fridge – that is keeping things cool! Therefore, when the capacitor goes for a toss, the entire mechanism of the fridge collapses, raising the need to summon a techie from a reputed company that carries out fridge repairs in Sydney or any other city in Australia

3.5. Fridge Thermostat.



fig. 3.5. Fridge Thermostat.

Technically, a fridge can run sans a thermostat, as it is just an on and off switch for the compressor. Thus, when the temperature reaches the point that is preset. Generally, it goes off 2 to 3 degrees below that point.

There are other ways of testing the thermostats' functionality though. The modern thermostats come with LCD screens. You can check the thermostat's screen to see if its lights are on. If you find the LCD screen to be blank and unlighted, it would indicate that the thermostat has failed and is not working properly. You need to check the batteries. Modern batteries are powered by batteries. Hence, you need to change the battery to find out if it works. If not, you must hire an expert offering **fridge repairs in Potts Point**.

3.6. Fridge Defrost Timer.

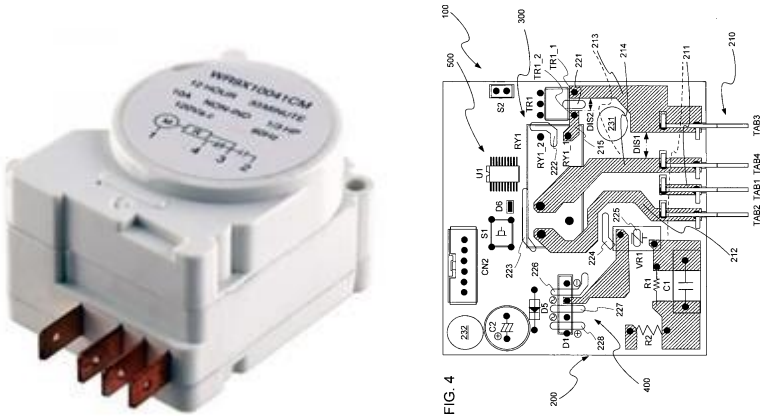


fig. 3.6. Fridge Defrost Timer.

The defrost timer is typically provided to remove frost on an evaporator in a refrigerator. The defrost timer includes a circuit board, a first terminal, a second terminal, a third terminal, a fourth terminal, a switching unit, a first AC line, a second AC line, a third AC line and a fourth AC line. The first AC line is provided on the circuit board and connects the first terminal and the switching unit. The second AC line is provided on the circuit board and connects the second terminal and the switching unit. The third AC line is provided on the circuit board and connects the third terminal and the switching unit. The fourth AC line is provided on the circuit board and connects the fourth terminal and the switching unit. Distance between the third AC line and the fourth AC line is at least 5 mm.

3.7. Refrigerator Defrost Heater.



fig. 3.7. Refrigerator Defrost Heater

Recall that a defrost heater melts the frost developed over the evaporator coil. To troubleshoot the heater first, check if it turns on when in diagnostic test mode.
We should check whether the frost starts to melt in the test mode. If the frost melts in the test mode, the heater is working fine. Unplug the refrigerator to exit the test mode.
If the defrost heater doesn't work in the test mode, check for continuity through the defrost heater circuit. For checking the continuity of the circuit, the refrigerator temperature should be below 46℃

We need to remove the control panel down to access the electronic control board. Then, check the defrost heater circuit by putting multimeter leads on the wires connected to the control board.
The circuit has continuity if the multimeter reads about 10 to 150 ohms. If the circuit has continuity, then defrost heater is working fine.

If the defrost heater circuit does not have continuity, then defrost heater is faulty. We need to replace the faulty defrost heater.We need to remove the mounting screws from the evaporator cover to access the defrost heater. Disconnect wiring harness connected to defrost heater. We should slide the defrost heater out and insert a new defrost heater back up under the evaporator.

3.8. Refrigerator Cooling Fan.



fig. 3.8. Refrigerator Cooling Fan.

The primary purpose of the industrial cooling fans is to blow cold air and drive hot air out of the environment. Therefore these industrial fans are also called industrial cooling blowers. However, cold air intake or hot air exhaust depends on the design and construction of the specific fan.

3.9. Fridge Door Switch.



fig .3.9. Fridge Door Switch.

The door switch used in fridges is typically a type of micro switch, also known as a snap-action switch. These switches have a small actuator button that moves when the door is opened or closed, which triggers the switch's contacts to open or close.

3.10 Refrigerator Light.



fig 3.10 Refrigerator Light.

unlite LED A15 Refrigerator Light Bulb, 6 Watts (40W Equivalent), 450 Lumens, Medium Base (E26),Dimmable, Frosted Finish.

Mechanical System

3.11. Refrigerator Cooling Compressor

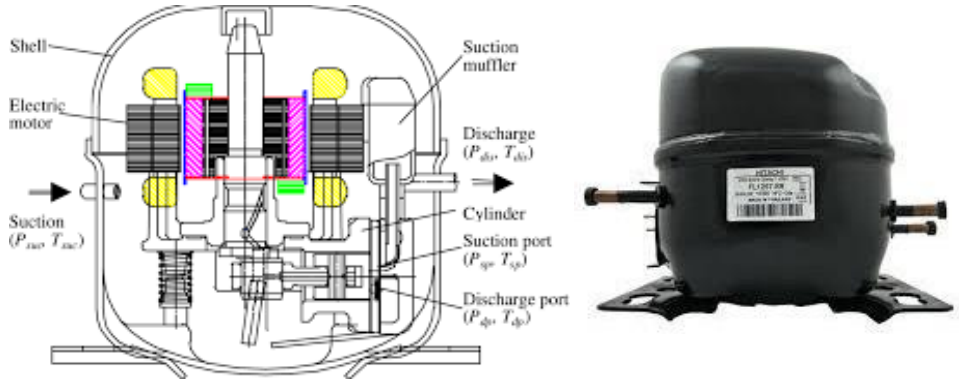


Fig.3.11. Refrigerator Cooling Compressor

In recent years, application of vapor compression refrigeration systems for cooling of electronic devices has been the subject of many investigations [1], [2], [3], [4], [5], [6], [7], [8], [9], [10], [11], [12], [13], [14], [15], [16], [17], [18]. The research is driven by the need to develop advanced cooling systems capable of maintaining the high heat flux electronics, telecommunication equipment, and high-end computers within their operating temperature. Amit et al. [1], in their work on the effect of thermostatic expansion valve characteristics on the stability of refrigeration system, indicated that the primary purpose of low temperature cooling using vapor compression systems: are faster switching times of semiconductor devices, increased circuit speed due to lower electrical resistance of interconnecting materials, and reduction in thermally induced failures of devices and components. In an investigation on the application of conventional refrigeration system to cool IBM's S/390 mainframe, Schmidt [2] showed that the chip temperatures can be maintained below that of comparable air-cooled systems, but well above cryogenic temperatures. The development of a Kleemenko cooler, which provides 80 watts of refrigeration for the

CPU at −96 °C, is perhaps one of the significant advances in cooling of computers [3]. In addition to high cooling performance, refrigeration systems can remotely be employed to remove heat from a source.
Pepples [4] showed that the vapor compression systems can reject heat far from the source by separating the evaporator and condenser in a so-called “split system”.
Some of the major concerns in the application of refrigeration systems to cool electronics include condensation of the evaporator cold plate where the electronics components are mounted. Condensation will occur on all surfaces when the temperature is below the dew point temperature of the surrounding air. The resulting liquid water is perilous to the operation of electronics. Therefore, insulation of the exposed surfaces is needed to prevent hazards. Another concern is the systems lagging response to applied load at the evaporator. This lagging response is attributed to delay in the transmission of the thermal signal from the Thermostatic Expansion Valve (TXV) bulb to the actuator of the thermal expansion valve.
Typically, the TXV bulb is connected to the outlet of the evaporator to sense the superheat temperature and send a signal to the TXV actuator to increase or decrease the mass flow rate accordingly. The bulb encounters a time delay in conveying the signal to the TXV actuator; which in turn delays the flow of refrigerant to the evaporator. This delay causes the refrigeration system to become unstable, and hence results in damage to system components [5].
Several studies have been performed to investigate the unsteady phenomena in refrigerators. In a theoretical study of the transient response of the vapor-mixture transition point in horizontal evaporator flow, Wedekind et al. [6] showed that the value of the evaporator time constant ranges from 5.5 to 7 s; the evaporator time constant is the time required for the refrigerant to evaporate fully all excess refrigerant assuming constant heat addition to the refrigerant or the time required to overcome the refrigerant shortage provided the mass flow rate remains constant. Danning [7] in his study of the liquid feed regulation of thermostatic expansion valve reported an evaporator time constant of 234 s. In a study on refrigeration control with varying condensing pressure, Green et al. [8] reported an evaporator time constant in the range of 0–120 s. Also, in a theoretical study on the performance instability of a refrigerator with its evaporator controlled by a thermostatic expansion valve, Tahat et al. [5] derived the evaporator time constant to study the effect of the evaporator’s external parameters on the dynamic behavior of the refrigeration system. In their work, they showed that the magnitude of the time constant is 2 and 5 s, respectively for 100 and 50% loads imposed on the refrigerator.
A review of literature reveals that very little experimental work has been done to measure the evaporator time constant, and that the reported values of the evaporator time constants differ significantly. These values range from 2 s reported by Tahat et al. [5] to 234 s reported by Danning [7]. Further experimental investigation is needed to measure the evaporator and TXV time constants. This information is of practical relevance to thermal engineers and scientists for efficient design of advanced vapor compression refrigeration systems for cooling of electronic devices. The lagging response of refrigeration systems to imposed load may result in the electronic device exceeding its operating junction temperature and consequently leads to failure.
This paper provides a systematic experimental method of studying the transient response of the vapor compression refrigeration systems processes to fluctuation in applied load. The objectives of this investigation are to design and construct a vapor compression refrigeration system for the cooling of electronics, to study the transient response of the refrigeration system to variation of applied loads, and to measure the evaporator and TXV time constants.

3.12. Refrigerator Condenser.

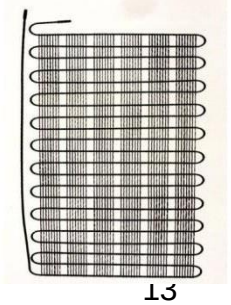


Fig.3.12. Refrigerator Condenser.

The condenser removes heat from the hot refrigerant vapor gas vapor until it condenses into a saturated liquid state, a.k.a. condensation. After condensing, the refrigerant is a high-pressure, low-temperature liquid, at which point it's routed to the loop's expansion device

3.13. Refrigerator Filter

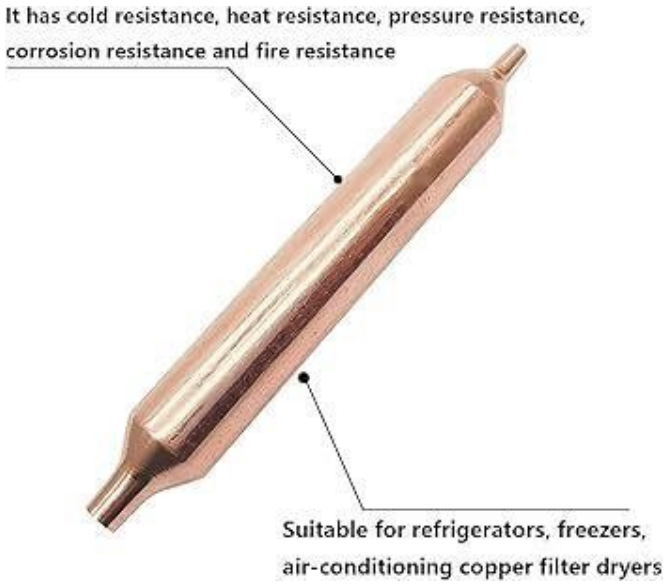


Fig.3.13. Refrigerator Filter

Refrigerator water filters work by filtering tap water between your water supply and the built-in water dispenser or ice maker. Refrigerator water filters are usually found inside the refrigerator itself or are attached to the water line outside the fridge.

Many refrigerator water filters use activated carbon to filter out physical impurities in the water supply, but there may be other components to the filter as well.

Since refrigerator water filters are built directly into the appliance, you may not have a lot of choice in which type of filter comes with your refrigerator. You'll need to replace it on a regular basis to maintain its effectiveness, so you can choose to replace it with a filter from the original equipment manufacturer or a third-party

3.14. Freeze capolary



Fig3.14. Freeze capolary

he size of tubing like a capillary tube to effectively carry out its function must match the thermodynamic characteristics of the gas or liquid that will be passing through the tube, together with the amount of available pressure, the volume and flow requirements of a system..

Which means that as stated above, the size of a capillary tube matters..in order to satisfactory perform the required function, usage and application of the tube..

3.15. Refrigerator Evaporator.

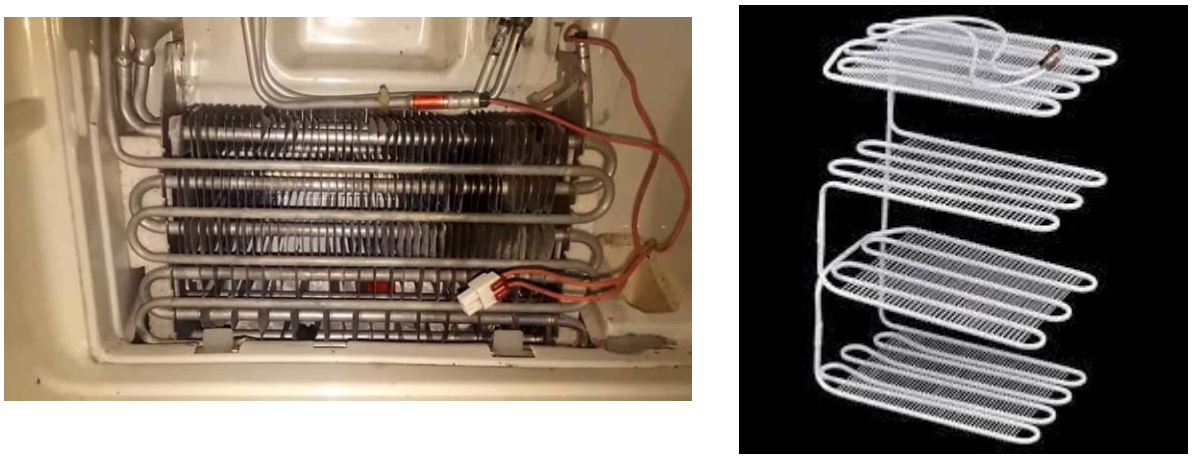


Fig.3.15. Refrigerator Evaporator.

In refrigeration, an evaporator is the heat exchanger where the refrigerant circulating inside the refrigeration circuit absorbs the thermal energy from the environment, which is then cooled. This is how the state of the refrigerant changes from liquid to vapour, giving it its name. As a result, the refrigerant evaporates to absorb the temperature or energy from the environment to be cooled.

It function relies on transmitting, as efficiently as possible, the thermal energy from the environment to be cooled (it can be a cold room or a secondary fluid as in the case of indirect refrigeration systems) to the fluid that is evaporating (in this case the main refrigerant).

3.16. High pressure Gas Cylinder valve



Fig3.16.High pressure Gas Cylinder valve

High pressure valves are used to regulate the flow of liquids, gases and other media through tubing, pipes, tanks, and other containers. There are several valve types to choose from, including some that provide on/off control.

3.17 Experimental Design.

3.17.1 Electrical Diagram of Frost Refrigerator

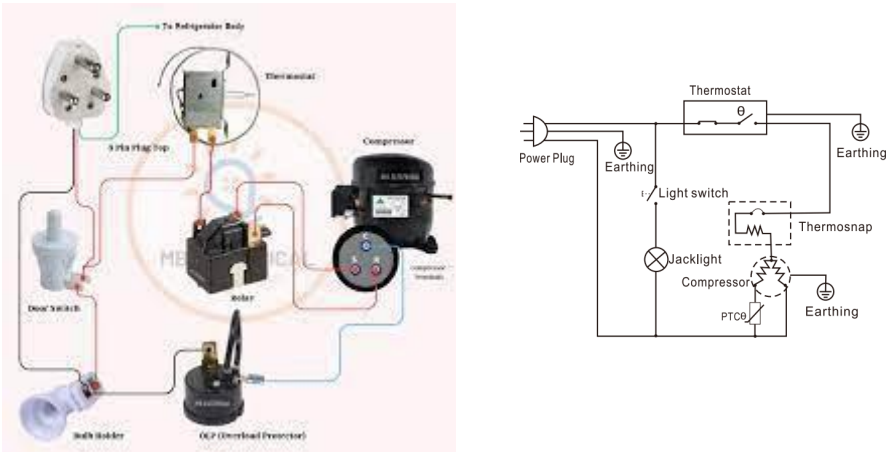


Fig. 3.16.1 Electrical Diagram of Frost Refrigerator

3.17.2 Electrical Diagram of non Frost Refrigerator

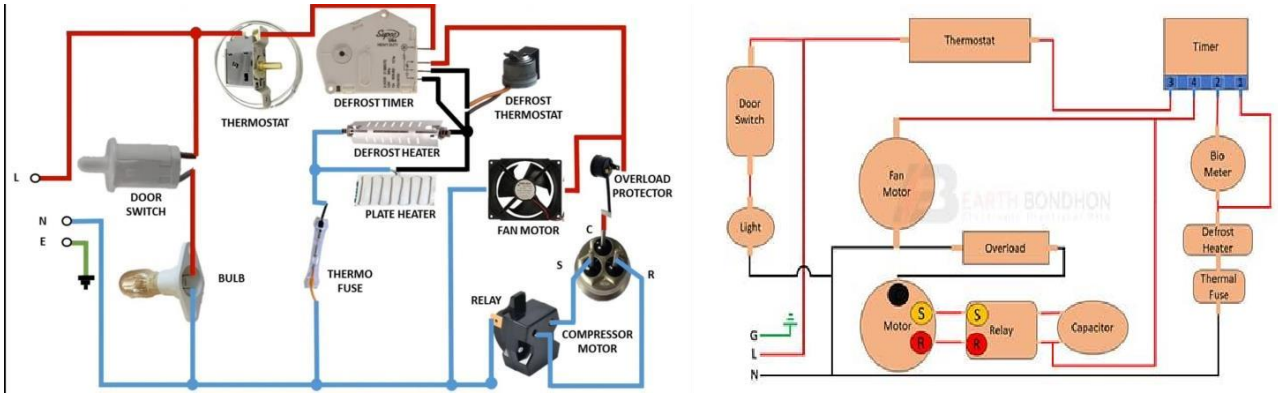


Fig.3.16.2 Electrical Diagram of non Frost Refrigerator

This circuit shows how to make Non-Frost Refrigerator wiring. In this circuit, we use a door switch, a thermostat, a timer, a fan motor, an overload, a capacitor, a defrost heater, a thermal fuse, and a biometer

3.17.3 Mechanical Diagram of Refrigerator

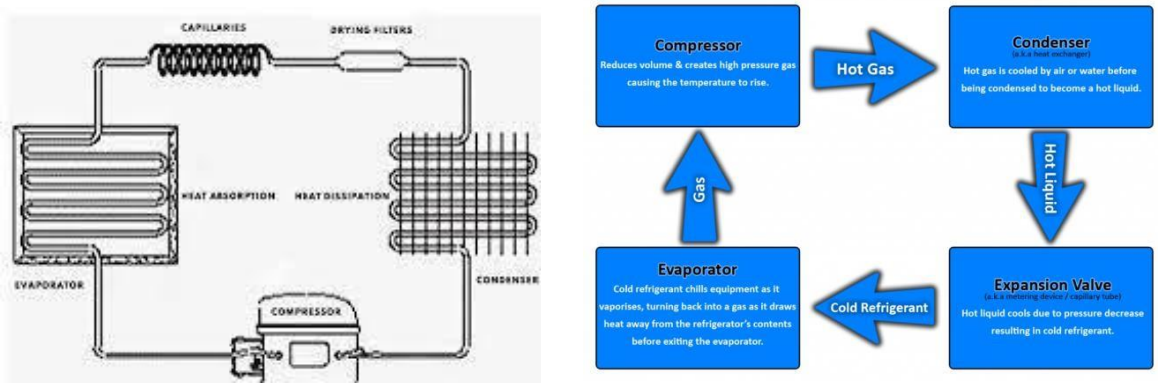


Fig. 3.16.3 Mechanical Diagram of Refrigerator

The refrigeration cycle starts and ends with the compressor. The refrigerant flows into the Compressor where it is compressed and pressurised. At this point, the refrigerant is a hot gas. The refrigerant is then pushed to the Condenser which turns the vapour into liquid and absorbs some of the heat. The refrigerant then proceeds to the Expansion Valve where it expands, losing pressure and heat.

The refrigerant coming out of the expansion valve is cold and slow due to the loss of pressure. It enters the **Evaporator** in a liquid state where the exchange of heat takes place thus cooling the load inside the refrigerator. As the gas cools down the load, it absorbs the heat which turns it into a gas. The gas is then pushed back into the Compressor where it can start the cycle again.

During the refrigeration cycle, a build-up of ice around the evaporator may occur. Both commercial fridges and freezers will combat this build-up with some form of defrost system.

CHAPTER 4

THE DESIGN METHODS AND PROCEDURES

4.1 ABSTRACT

The aim of this paper is to design analysis of Regular 190L household direct cool vertical evaporator refrigerator with refrigerant 134a. In this household refrigerator. The usable cabinet space is improved by 25~30 % with roll bond vertical evaporator by instead of conventional c or o type roll bond evaporator. This improvement in usable space is based on the volume of existing evaporator ie. freezer section of house hold a direct cool refrigerator. The design finalization of cooling circuit and internal volume of the vertical evaporator is done based on 43° no load pull-down test and 32°C energy test. Based on 43°C pull-down test, freezer section becomes warmer by approximately 9°C~12°C so it can be considered as a refrigerator without a freezer compartment. A further extension this vertical evaporator, one perforated cover is added to this bare roll bond panel of vertical evaporator from customer safety and aesthetic point of view and this vertical evaporator refrigerator with 1 perforated cover then compared with baseline refrigerator. The energy improvement found with vertical evaporator refrigerator with 1 perforated cover when compared to.

4.2 INTRODUCTION

The usable cabinet space of household direct cool refrigerator is improved by use of roll bond vertical evaporator instead of conventional c or o type roll bond evaporator. This usable space decided based on the volume of existing evaporator i.e. freezer compartment and refrigerator compartment however in this project freezer compartment is converted into the refrigerator compartment. In this project for R190L refrigerator 3 cooling circuits based on their internal volumes 120CC, 140CC & 170CC are designed and analyzed. The energy improvement found in R190L 170CC vertical evaporator refrigerator is 3~6 % compared to its 120CC & 140CC vertical evaporator refrigerators, so based on 43°C NLPD and 32°C energy tests 170CC internal volume circuit is considered as a final cooling circuit. As per Bureau of energy efficiency (BEE) guidelines, in 43°C NLPD test freezer compartment temperature should be colder than -8°C temperature, which is not reaching in case of vertical evaporator refrigerator so it can be registered under 'refrigerator without freezer compartment' category. Further perforated sheets are added to cover bare roll bond panel ie evaporator, in which 170CC cooling circuit with 1 perforated cover found the most energy efficient. Then comparative 43°C NLPD and 32°C energy tests are done on baseline R190L refrigerator and R190L 170CC cooling circuit with 1 perforated cover ie vertical evaporator refrigerator. The energy improvement found in vertical evaporator refrigerator is 9~10 % compared to baseline refrigerator. 2. LITERATURE REVIEW A first-principles mathematical model developed to investigate the thermal behavior of a plate-type, roll-bond evaporator by Christian J. L Hermesa, et.al [1]. The refrigerated cabinet was also taken into account in order to supply the proper boundary conditions to the evaporator model. The mathematical model was based on the mass, momentum, and energy conservation principles applied to each of the following domains: (i) refrigerant flow through the evaporator channels; (ii) heat diffusion in the evaporator plate; and (iii) heat transmission to the refrigerated cabinet. Empirical correlations were also required to estimate the shear stresses

4.3 LITERATURE REVIEW

A first-principles mathematical model developed to investigate the thermal behavior of a plate-type, roll-bond evaporator by Christian J. L Hermesa, et.al [1]. The refrigerated cabinet was also taken into account in order to supply the proper boundary conditions to the evaporator model. The mathematical model was based on the mass, momentum, and energy conservation principles applied to each of the following domains: (i) refrigerant flow through the evaporator channels; (ii) heat diffusion in the evaporator plate; and (iii) heat transmission to the refrigerated cabinet. Empirical correlations were also required to estimate the shear stresses

and the internal and external heat transfer rates. The governing partial differential equations were discretized through the finite volume approach and the resulting set of algebraic equations was solved by successive iterations. Validation of the model against experimental steady-state data showed a reasonable level of agreement: the cabinet air temperature and the evaporator cooling capacity were predicted within error bands of 1.5 C and 6%, respectively. This paper helps to investigate the thermal behavior of a plate-type, roll-bond evaporator. This paper doesn't give any idea regarding design and analysis of a vertical roll bond evaporator. In international engineering research journal paper by AshishMatkar, et.al [2] the design and analysis of direct cool refrigerator with vertical evaporator is studied. In this paper effect of vertical evaporator on performance in the household refrigerator instead of conventional O or C type evaporator is studied but the experimentation and analysis are done with R134a refrigerant whereas impact with R600a refrigerant is not discussed. The investigation was done by Erik Bjork, et.al [3] for the flow boiling heat transfer in a typical domestic refrigerator evaporator with horizontal flow, frequent bends, and a non-circular cross-section. The mass flux was varied between 21 and 43 kg/m2 s, the heat flux between 1 and 5 kW/m2 and the vapor quality between 0.2 and 0.8. In spite of a predicted stratified to wavy-stratified flow pattern complete tube perimeter wetting was believed to occur except for the lowest mass flux and for positions upstream of the first bend. It was concluded that the bends helped to wet the tube perimeter. The experimental data revealed heat transfer coefficients higher than predicted with conventional correlations. This was suggested to be explained by thin film evaporation at a perimeter repeatedly wetted by liquid slugs. A simple correlation based on the pure convective part of the Shah correlation was derived from the experimental data. The mean deviation of this was 16.9% compared to Shah's 54.7%. This paper helps to investigate the flow boiling heat transfer in a typical domestic refrigerator evaporator with horizontal flow, frequent bends, and a non-circular crosssection. This paper doesn't give any idea regarding design and analysis of a vertical roll bond evaporator. A study is presented on the influence of the air flow rate and surface geometry on the thermal-hydraulic performance of commercial tube-fin 'no-frost' evaporators by Jader R. Barbosa JR. et.al [4]. A specially constructed wind-tunnel calorimeter was used in the experiments from which data on the overall thermal conductance, pressure drop, Colburn j-factor and Darcy friction factor f were extracted. Eight different evaporator samples with distinct geometric characteristics, such as the number of tube rows, number of fins and fin pitch were tested. Semi-empirical correlations for j and f are proposed in terms of the air-side Reynolds number and the finning factor. A discussion is presented on the performance of the evaporator with respect to specific criteria such as the pumping power as a function of heat transfer capacity and the volume of material in each evaporator. This paper helps to study influence of the air flow rate and surface geometry on the thermal-hydraulic performance of commercial tube-fin 'nofrost' evaporators. This paper doesn't give any idea regarding design and analysis of a vertical roll bond evaporator. The presentation of a new model for fin-and-tube evaporators, focusing on the solid core simulation and its integration with a quasihomogeneous two- phase flow model for the in- tube refrigerant flow was done by C. Oliet, et.al [5]. Special attention is given to separate in-tube flow patterns (stratified, stratified- wavy), because of their importance in liquid overfeed and domestic refrigerator evaporators and the impact on the solid core temperature distribution. The paper presents the solid core formulation and numerical method, the in-tube two-phase flow model, and describes the proposed integration algorithm between them. A selected singletube baseline case is analysed in full detail, showing the impact of stratified flow on the fin-and-tube temperature distributions. Additional studies are finally presented analysing different flow transitions (single phase to stratified flow, stratified-wavy flow to annular flow, and annular flow to partial dry-out) and several operating parameters (flow regime, tube material, and tube thickness). This paper is devoted to the presentation of a new model for fin-and-tube evaporators, focusing on the solid core simulation and its integration with a quasi-homogeneous two-phase flow model for the in-tube refrigerant flow.

This paper doesn't give any idea regarding design and analysis of a vertical roll bond evaporator. The study was done by Anand M. Shelke, et.al [6] on the design of solar sterilizer assisted with aqua ammonia solar vapour absorption system. The projects deal with the fulfillment of sterilized safe drinking water at cheap & reliable cost as well as usage of nonconventional solar energy source. It consists of a combined system having water sterilizer that usage evacuated tubes and aqua ammonia vapour absorption system. The study was done by Sandip S. Sisat, et.al [7] on performance and evaluation of blends of hydrocarbon (R134a/R290 and R134a/R600a) in the household refrigerator as hydrocarbon are the best-suited fluid for

alternatives to conventional refrigerants. The study was done for usage

of blends of R134a/R290 and R134a/R600a for experimentation at the different mass percentage of refrigerants for different load conditions.

4.4 HEAT LOAD CALCULATIONS FOR DIRECT COOL REFRIGERATOR WITHOUT FREEZER COMPARTMENT

Below are the steps defined to make the design calculations for the refrigerator. All the design calculation for the refrigerator is based on heat and mass transfer fundamentals.

Step 1- Calculation of outside Heat Transfer Coefficient (ho)
Step 2- Calculation of Internal Heat Transfer Coefficient (hi)
Step 3 -Wall Heat Load Calculations
Step 4 - Air Change Load Calculations
Step 5 - Calculations for Commodity Load for Refrigerator
Compartment Step 6 - Calculations for Commodity Load for
Freezer Compartment Step 7 - Calculation of Water Load for RC
Step 8 - Calculations for Water Load for FC
Step 9 - Total Heat Load with freezer compartment
Step 10 - Total Heat Load without freezer
compartment
Step 11 –Comparison of Total Heat Load with and without freeze

Step 1- Calculation of outside Heat Transfer Coefficient (ho) On Condenser Coil For outside heat transfercalculation, outer wall temperature is considered based on air-cooled condenser temperature and ambient temperature. For calculating heat transfer coefficient calculated Grasoff No as per given formula. Value of Prandtl No (Pr) is taken from property table and calculated outside heat transfer coefficient based on below formula. Table 3.1 shows the calculated values of outside heat transfer coefficient.

Gr = g×β×θ×L/3 ϑ 2 ----------3.1

Nu = 0.548(Gr × Pr) 1/4 ------3.2

When 105 < Gr. Pr> 1011 Nu = ho × L/K---- 3.3

Table 3.1: Calculation of outside Heat Transfer Coefficient
(ho) Twall = 47°C
Tamb = 43°C
Tmean = 45°C

Taking properties of air at
45°C ho = 3.6

Step 2- Calculation of Internal Heat Transfer Coefficient (hi)

For inside heat transfer calculation inside wall, temperature is considered based on evaporator temperature and inside surface temperature. For calculating heat transfer coefficient Reynolds No (Re) and Prandtl No (Pr) is taken from property table and calculated inside heat transfer coefficient based on below formula.

g=acceleration due to Earth gravity

β=volumetric thermal expansion coefficient (equal to approximately 1/T, for ideal gases, Where This absolute temperature)

Ts= Surface temperature

T∞= bulk temperature

L=characteristic length

D=diameter

V=kinetic viscosity

Nu = 0.548 × (Gr × Pr)1 /4 . . . . . for 105 <□□ × Pr< 1011 ----------3.5

Internal Heat Transfer Coefficient (hi) based on natural convection.
T liner FC = -13°C T
in FC = -12°C
T mean FC = -12.5°C
T liner RC = +2°C
T in RC = +1°C
T mean RC = +1.5°C
Taking properties at -12.5 mean air temperature.
hi for FC = 1.423
hi for RC = 1.391
Step 3 -Wall Heat Load Calculations Wall load calculations are finalized on the basis of required refrigerator capacity, performance, and energy requirement for the refrigerator. As shown in Table 3.1 inside and outside surface area of each refrigerator and freezer walls is calculated. The thermal resistance considering inside and outside convection and conduction for the each surface of refrigerators like liner, insulation and sheet metal part for each wall of the refrigerator and freezer compartment is calculated. The total thermal resistance of each refrigerator and the freezer wall is calculated. Then heat transfer of each wall of refrigerator and freezer compartment is calculated.

$R1 = 1/(ho \times Ao)$----- 3.5
$R2 = bCRCA/(KCRCA \times ACRCA)$ 3.6
$R3 = bInsulation/(KInsulation \times AInsulation)$ ----3.7 $R4 = bLiner/(KLiner \times ALiner)$ 3.8
$R5 = 1/(hi \times Ai)$ --3.9
$Rt = R1+ R2+ R3+ R4 +R5$ -----3.10 $Q = (To - Ti)/Rt$3.11

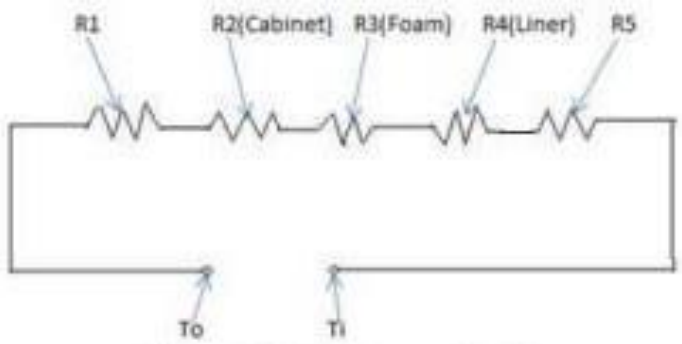


Figure 3.1: Resistance circuit

Table 4.1: Wall Heat Load Calculations

Walls	To	Ti	hi	ho	Ao
RC Side Wall LHS	43	+2	1.3912	3.06	0.62
RC Side Wall RHS	48	+2	1.3912	3.06	0.62
RC Back Wall	48	+2	1.3912	3.06	0.88
RC Door	43	+2	1.3912	3.06	0.71
RC Bottom Wall	43	+2	1.3912	3.06	0.23
Comp. Deck-Depth	43	+2	1.3912	3.06	0.10
Comp. Deck-Height	43	+2	1.3912	3.06	0.12
FC Top Wall	43	-12	1.423	3.06	0.34
FC Side Wall LHS	48	-12	1.423	3.06	0.33
FC Side Wall RHS	48	-12	1.423	3.06	0.33
FC Back Wall	53	-12	1.423	3.06	0.36
FC Door	43	-12	1.423	3.06	0.29

Table 4.2: Wall Heat Load Calculations

Walls	**T (total)**	**Q (watts)**
RC Side Wall LHS	5.17	9.48
RC Side Wall RHS	5.22	10.35
RC Back Wall	5.12	10.54
RC Door	5.26	9.31
RC Bottom Wall	12.69	3.86
Comp. Deck-Depth	34.27	1.43
Comp. Deck-Height	29.70	1.65
FC Top Wall	11.02	5.53
FC Side Wall LHS	13.34	4.95
FC Side Wall RHS	13.34	4.95
FC Back Wall	14.08	5.04
FC Door	15.13	4.03

Total Thermal Wall Heat Load (W) = 69.54 Watts.

Step 4 - Air Change Load Calculations

Gupta Gagan, Sugumaran .S; International Journal of Advance Research and Development. © 2017, www.IJARND.com All Rights Reserved Page | 11 Air change load is calculated based on outside and inside humidity ratio and also considered sensible heat and latent heat. Table 3.4 shows the input values of temperatures and calculated values of inside humidity, outside humidity, sensible heat transfer, latent heat transfer and the total heat transfer due to air change. Eqs.(3.12) and Eqs. (3.13) Shows the formula to calculate sensible heat transfer and latent heat transfer respectively.

$Qs = \rho * QAir * Cp(To - Ti)$ ----- 3.12

$Ql = \rho * QAir * Cp(Wo - Wi)$ ----- 3.13

For FC

Air change Load = V x Air x 0.75 x (hi –ho) /24

= 3 x 36 x 0.75 x (5 66-3.06) /24

=8.7 BTU/hr

Air change Load = 2.54

Watts **For RC**

Air change Load = V x Air x 0.75 x (hi –ho) /24

= 9 x 36 x 0.75 x (5.66-3.06) /24

=3.84 BTU/hr

Air change Load = 6.38 Watts.

Step5- Calculations for commodity load for Refrigerator compartment

Q= {weight of commodity (lb) x delta T°C x Sp. Heat ((btu/lb)/F) } / 24

= 9.027 Watts-------3.14

Table 4.3 shows the commodities taken in Consideration based on consumer's normal usage and its weight based on storage space available in the refrigerator compartment. The normal temperature of a commodity is considered as 30°C and storage temperature of each type of commodity defined based on dew point temperature. Then the specific heat of each commodity calculated as shown in the formula in Eqs. (3.14). Then heat transfer rate of each commodity for refrigerator compartment is calculated.

For RC:

Table 4.3: Commodity Load for RC

Sr No	Commodity	Q Watts
1	cabbage	0.994967
2	carrots	0.762102
3	cucumber	0.363782
4	tomatoes	0.867735
5	Apples	0.857768
6	coconut	0.585869
7	Lemon	0.314878
8	Grapes	0.868702
9	Water	0.1.681739
10	milk	0.910289
11	Fish	0.819421

Total Commodity load in RC (W) = 9.02725 Watts.3.14

Step 6 - Calculations for Commodity Load for Freezer Compartment.

Table 4.4 shows the commodities taken in consideration based on consumer's normal usage and its weight based on storage space available in the freezer compartment. The normal temperature of a commodity is considered as 30 °Cand storage temperature of each type of commodity is defined based on dew point temperature. Then the specific heat of each commodity is calculated as shown in the formula in Eqs. (3.15). Then latent heat conversion is considered since in freezer compartment phase change happens at 0°C.

Then heat transfer rate of each commodity for freezer compartment is calculated.

Q= { weight of commodity (lb) x delta T°C x Sp. Heat ((Btu/lb)/F) +Lt. heat (Btu/lb) } / 24 = 923.10 Watts3.15

For FC:

Table 4.4: Commodity Load for FC

Sr No	Commodity	Watts
1	Meat	1.854577
2	Chicken	2.39398
3	Icc cream	5.798294
4	Icc	13.05632

Step 7 - Calculation of Water Load for RC

Water load for refrigerator compartment is calculated based on the normal water temperature of 30℃ to the drinkable water temperature of 13℃. The amount of water quantity considered based on storage space available and normal usage pattern of the consumer. The total heat transfer rate for water in refrigerator compartment is calculated

Q= {weight of water (lb) x delta T°C x Sp. Heat ((Btu/lb)/F) } / 24 = 14.76 Watts ----------3.16

Step 8 - Calculations for Water Load for FC

Water load for freezer compartment is calculated based on the normal water temperature of 30℃ to the ice temperature of -5℃. The amount of water quantity considered based on storage space available and normal usage pattern of the consumer. Then latent heat conversion is considered since in freezer compartment phase change happens at 0℃. The total heat transfer rate for water in the freezer compartment is calculated.

Q= {weight (lb) x delta T°C x Sp. Heat ((Btu/lb)/F) x weight of water (lb) x Lt. Heat (Btu/lb)} / 24 --------- 3.17

For FC

Q = (wt x delta T x Sp) + (wt x latent heat) / 24 3.18 = { 7.04 × [30 - (-4)] × 1 + 7.04 × 144 } /24 = 15.28 W

For RC

Q = (wt x delta T x Sp) + (wt x latent heat) / 24 3.19 = { 31.9 × [30 - (13)] × 1 + 31.9 × 144 } /24 = 6.612 W

For Chiller

Q = { 4.4 × [30 - (1.5)] × 1 + 4.4 × 144 } /24 = 1.52 W 3.20 Total water commodity load = 23.42 Watts.

Step 9 - Total Heat Load (W) with freezer compartment

The total heat load to be handled in the refrigerator is the sum of heat from sources as: Heat load from walls Heat load from entering air i.e. Air change load Heat load from commodity load Heat load from water andice

Table 3.5 shows the total thermal load of freezer and refrigerator compartment. Total thermal load for the 190L conventional refrigerator is 137.08 watts.

Table 4.5: Total Thermal Load for Refrigerator (with freezer compartment

Sr No	**Parameters**	Q-FC (W)	Q-RC (W)	Q Total (W)
1	Thermal Wall Load	6.14	63.12	69.26
2	Air Change Load	2.54	3.84	6.38
3	Commodity Load	23.10	9.02	32.12
4	Water Load	15.28	14.76	30.04
Total heat Load (W)				137.08

As per heat load for given platform size, we can select the compressor from compressor manufactures catalogs to achieve cooling performance as per requirement and energy target for that cooling target, next we select the

condenser and evaporator for given data of heat load. In this project, focus is on condenser selection and improvement in condenser performance improvement from given data by keeping all parameter constant like compressor, platform size, evaporator, capillary length, heat load.

Step 10 - Total Heat Load (W) without freezer compartment

The total heat load to be handled in the refrigerator is the sum of heat from sources as: Heat load from walls
Heat load from entering air i.e. Air change load
Heat load from commodity load
Heat load from water and ice

Table 3.6 shows the total thermal load of freezer and refrigerator compartment. Total thermal load for the 190L conventional refrigerator is 96.88 watts.

Table 4.6: Total Thermal Load for Refrigerator (without freezer compartment)

Sr .s. No	Parameters	Q FC (W)	Q-RC(W)	Q Total (W)
1	Thermal Wall Load	6.14	63.12	69.26
2	Air Change Load	0	3.84	3.84
3	Commodity Load	0	9.02	9.02
4	Water Load	0	14.76	14.76
Total heat Load (W)				96.88

Step 11 – Comparison Total Heat Load (W) without freezer compartment

As from step 10 and Step 11 it is clear that, total heat load of the refrigerator without freezer compartment is less than total heat load of the refrigerator without freezer compartment so no need to change compressor specification in terms of cooling capacity and COP.

Step 12 – Selection of R134a compressor

Based on table 3.7, selected LGE MA42LPJG R134a compressor model for

testing Table 4.7: R134a compressor details

Compressor	134a Compressor
Make & Model	LGE R134a MA42LPJG
Cooling Capacity	107w
COP (W/W)	1.18COP
Displacement	4.2CC

4.5 Block Digram

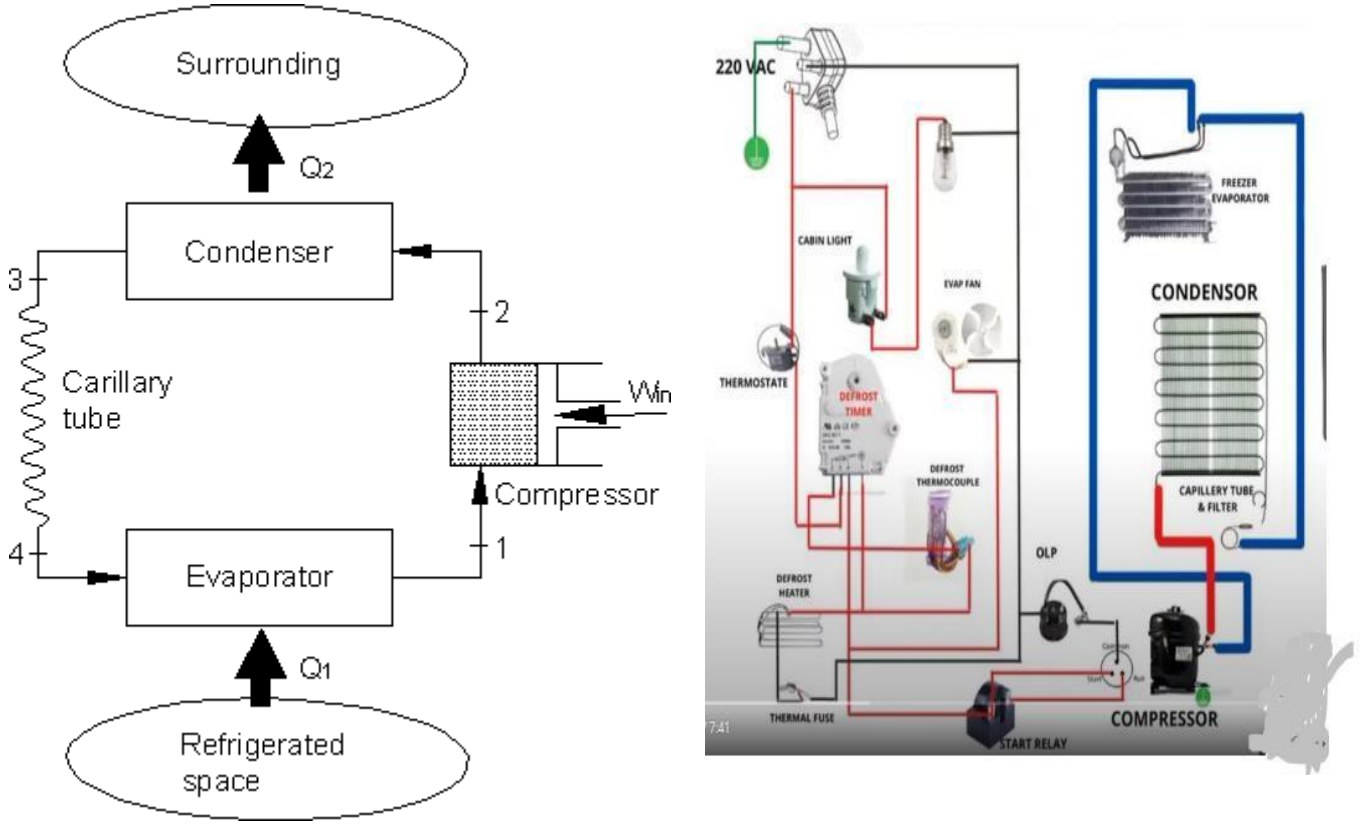


Fig 4.6 Diagram of Frost andnon Frost Refrigerator

4.7.Working principle

In this project , Although the given project has two chambers, with the help of a plressure valve, the gas flow should be stopped in one of the chambers and the gas flow should be opened in the other chamber by opening the pressure valve. To Start the frost phase chamber, the non frost timer switch should be dopt off. In this way, the same compressor and two chambers can be poerated by the same condenser.



fig :Design and fabrication of energy efficient of frost and non frost chamber of a refrigeration with the same compressor and condenser.

4.8 Project Cost Analysis

SI No	particulars	Specification	Qty	Unit Price (taka)	Total Price (taka)
1	Refrigerator compressor.	130 watt	1	4500	4500
2	Refrigerator fuse.	10A	1	60	60
3	Overload & Relay Protector		1	250	250
4	Refrigerator Capacitor.	3.5	1	120	120
5	Fridge Thermostat.	10A	1	650	650
6	Fridge Defrost Timer.	10A	1	550	550
7	Refrigerator Defrost Heater.	10A	1	650	650
8	Refrigerator Cooling Fan.	15Waat	1	800	800
9	Fridge Door Switch.	----	1	120	120
10	frost and non frost chamber	----------	2	1500	1500
11	condenser	-----	1	750	750
12	capolarytube,fiter	----------	1,1	500	500
13	pressure valve	----------	2	1250	1250
				Total	12000/=

CHAPTER 5

CONCLUSION

6.1 Conclusion

The refrigerator has come a long way since its ancient origins of using ice and snow to cool food and drinks. The invention of the modern refrigerator has revolutionized food storage and transformed the way we live. With continued advancements in technology, we can expect refrigerators to become even more efficient and convenient in the future. We hope you enjoyed learning about this amazing invention! Although the given project has two chambers, with the help of a plressure valve, the gas flow should be stopped in one of the chambers and the gas flow should be opened in the other chamber by opening the pressure valve. To Start the frost phase chamber, the non frost timer switch should be dopt off. In this way, the same compressor and two chambers can be poerated by the same condenser

6.2 Future Scope

We are thinking about adding many features to our project in the future to get more desirable outcomes. Some of the steps that we are thinking about taking are given below:

*In the future we are looking forward to improved of our whole system design to make it mote efficient.

*In the future this tilting mechanism with a collector can be implemented nodesign and fabrication of energy efficient of frost and non frost chamber of a refrigeration with the same compressor and condenser

*Loadshedding is high bye alternative method is to use frost chamber.keep food well for o long time .To improve sustainability and customer service

Reference

(1) *ASHRAE Handbook of Refrigeration*, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Atlanta, GA, 2002.

(2) R. Thevenot, *A History of Refrigeration Throughout the World*, International Institute of Refrigeration, Paris, France, 1979, pp. 39–46.

(3) K. W. Cooper and K. E. Hickman, " Refrigeration" in *Encyclopedia of Chemical Technology*, Vol. **20**, 3rd ed., Wiley, New York, 1984, pp. 78–107.

(4) C. E. Salas and M. Salas, *Guide to Refrigeration CFC's*, Fairmont Press, Liburn, GA, 1992.

5. U.S. Environmental Protection Agency, "The Accelerated Phaseout of Ozone-Depleting Substances," *Fed. Reg*., **58**(236), 65018–65082, December 10, 1993.

(6) U.S. Environmental Protection Agency, "Class I Nonessential Products Ban, Section 610 of the Clean Air Act Amendments of 1990," *Fed. Reg*., **58**(10), 4768–4799, January 15, 1993

(7) United Nations Environmental Program (UNEP), Montreal Protocol on Substances That Deplete the Ozone Layer—Final Act, UNEP, 1987.

(8) G. King, Basic Refrigeration, Business News, Troy, MI, 1986.

(9) Number Designation and Safety Classification of Refrigerants, ANSI/ASHRAE 34-2001, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Atlanta, GA,2001.

(10)G. G. Haselden, *Mech. Eng.*, **44**, March 1981.

(11) Safety Code for Mechanical Refrigeration, ANSI/ASHRAE 15-1994, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Atlanta, GA, 1994.

(12) *ASHRAE Handbook of Fundamentals*, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Atlanta, GA, 2001, Chapter 19.

(13) M. J. Molina and F. S. Rowland, "Stratospheric Sink for Chlorofluoromethanes: Chlorine Atoms Catalyzed Destruction of Ozone," *Nature*, **249**, 810–812, 1974.

(14) C. D. MacCracken, "The Greenhouse Effect on ASHRAE," *ASHRAE J.*, **31**(6), 52–55, 1996.

(15) U.S. Environmental Protection Agency (EPA), Ozone Depletion Website,