A PROJECT REPORT

ON

"MULTI-EVAPORATIVE AIR CONDITIONING SYSTEM"

Submitted by

KHAN FAISAL NADIM ZAHIRUDDIN	**17ME30**
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In partial fulfillment for the award of the Degree

Of

BACHELOR OF ENGINEERING

IN

MECHANICAL ENGINEERING

UNDER THE GUIDANCE

Of

Prof. ATUL MESHRAM

DEPARTMENT OF MECHANICAL ENGINEERING

ANJUMAN-I-ISLAM

KALSEKAR TECHNICAL CAMPUS NEW PANVEL,

NAVI MUMBAI – 410206

UNIVERSITY OF MUMBAI

ACADEMIC YEAR 2020-2021

ANJUMAN-I-ISLAM
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CERTIFICATE

This is to certify that the project entitled

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To the Kalsekar Technical Campus, New Panvel is a record of bonafide work carried out by him under our supervision and guidance, for partial fulfillment of the requirements for the award of the Degree of Bachelor of Engineering in Mechanical Engineering as prescribed by **University of Mumbai**, is approved.

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(Prof.____________________)

External Examiner
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(Dr. ABDUL RAZAK HONNUTAGI)

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APPROVAL OF DISSERTATION

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(Internal Examiner) **(External Examiner)**

___________________ ___________________

Date: __________

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DECLARATION

I declare that this written submission accurately reflects my ideas in my own terms, and that where other people's ideas or words were used, I properly cited and referenced the original sources. I also declare that I have followed all academic honesty and integrity standards in my submission and have not misrepresented, fabricated, or falsified any concept, data, fact, or source. I understand that any breach of the above would result in disciplinary action by the Institute, as well as legal action from the sources who were not properly cited or from whom proper permission was not obtained when required.

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ABSTRACT

Air conditioning units or the air conditioners are used in everyday life to cool the air around us. They are a very common consumer electronic device. Inside the air conditioner, refrigeration of some special gases takes place to give out cool air, much like in refrigerators. The air condition uses the simple principle that while changing from liquid state to gaseous state, the substance gives out heat. To send out, cold air, the air conditioner has special substance which is used as a refrigerant. This substance is evaporated and condensed continuously to give out cool air. This process takes place in the closed condition inside the unit.

There is a proper mechanism to pass the heat generated during this process out of the machine from the other end. In centralized air conditioners, there is a duct system to channel hot air away and keep the system from heating inside. The fan is also provided for the same reason. A compressor is also fitted inside the machine to convert the gas back to liquid. The compressor basically creates high pressure and converts the gas back to liquid so that the process continues and the temperature remains controlled. Thus, the refrigerant constantly maintains the indoor temperature and the inside temperature of the system is also controlled.

Concerning our project idea, we thought of designing a contrasting air conditioning system with remarkable abilities and customizable according to the consumer's needs. Multi Evaporative Air conditioning system consists of a compressor, a condenser, and miniature evaporators with accessory components. The designed system can work with single compressor and condenser units and multiple miniature evaporators fixed in a calculated number of rooms. We introduced the concept of storage tanks and vacuum isolated delivery pipes to ensure the proper mechanism of the system. The primary aim of our group was to minimize the consumption of power consumed by the system, to increase the productivity of the system, to reduce the time required to transfer the heat, and lessen the complexity when more than one unit is installed.

At present, Multi Evaporative Air conditioning system is sketched, designed, analyzed, and the rest of the calculations are theoretical. All the simulations and flow simulations are performed on 3D modeling software using these calculations and tend to vary in a real environment.

We tried our best to keep it as accurate and precise as possible. The entire explanation is provided in the following contents with figures of 3D models of the components and results of various analysis and simulations.

CHAPTER 1

INTRODUCTION

1.1: Problem definition

Nowadays, simple air conditioning is employed practically everywhere on a residential scale. Compressor, condenser, evaporator, and other components are included in the refrigeration system. To install this domestic air conditioning system, we'll need a unique setup for the entire system. To provide cooling, only one evaporator is used. To make a more efficient system, we want to build an air conditioning system in which a single setup will provide multiple evaporators to increase the cooling effect throughout the house.

By providing a single condenser and a single compressor to serve each of the evaporators, refrigeration systems of the type described above can reduce the cost of air conditioning or refrigeration in multiple evaporator units.

1.2: Aim/Objective/Purpose of the Study

- To modify the existing air conditioning system making it more useable at homes as well as on a commercial basis.
- To increase its cost-efficiency.
- To reduce its power consumption.
- To improve its Overall Cooling effect distribution.

1.3: Condition 1

This condition details if the user decides to turn on the evaporators of Room 1. In this case, the refrigerant filled in the rudimentary circuit will flow from the compressor to the evaporator and back.

As soon as the system is on, the user-selected room's solenoid valves will open and allow the refrigerant to flow through the evaporator to gain the required room temperature. Note that the storage tanks are closed and isolated from the system, i.e., the refrigerant in both of the storage tanks are not in use.

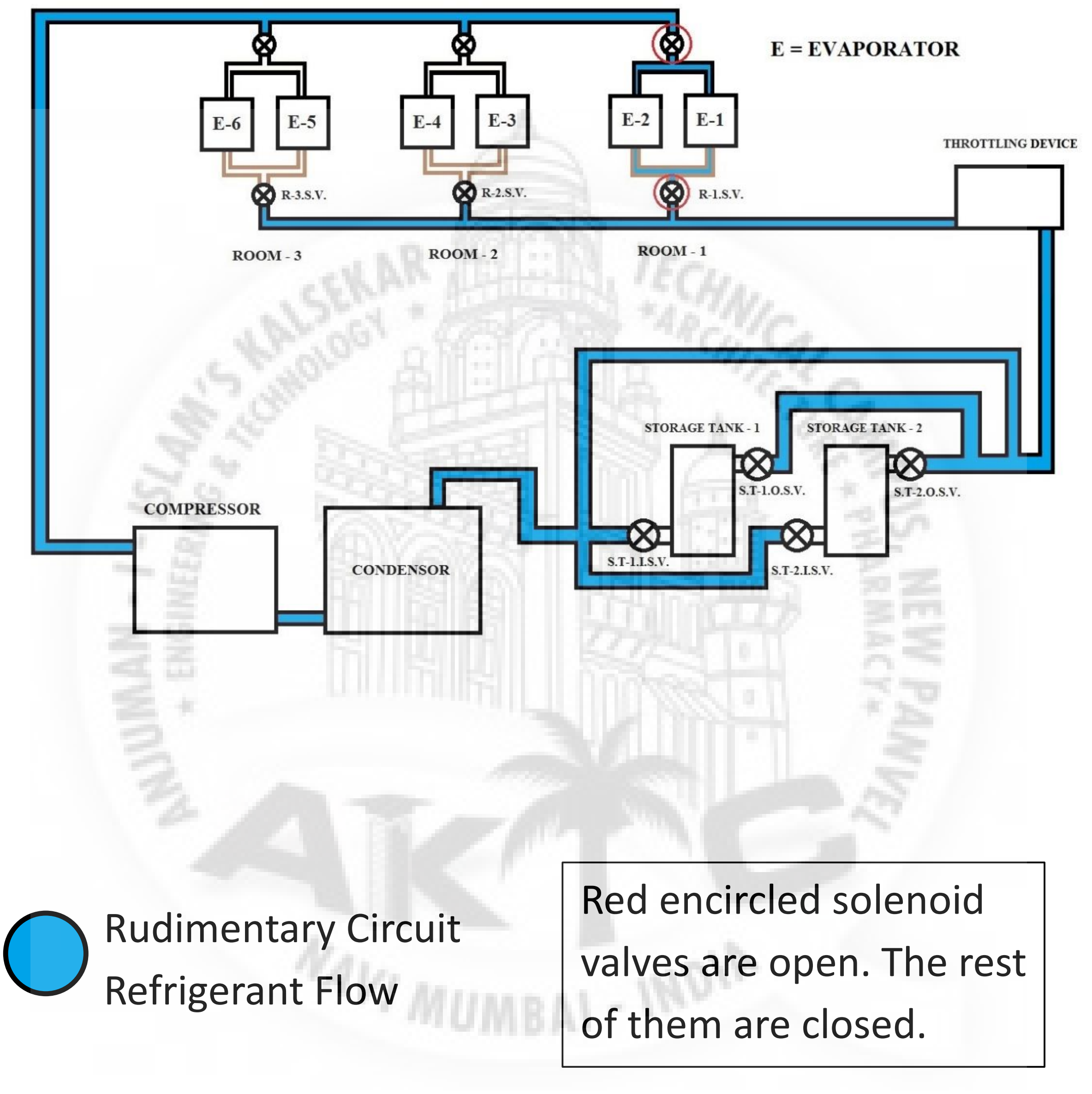


Fig 1.1: Rudimentary Circuit Refrigerant Flow, Condition 1

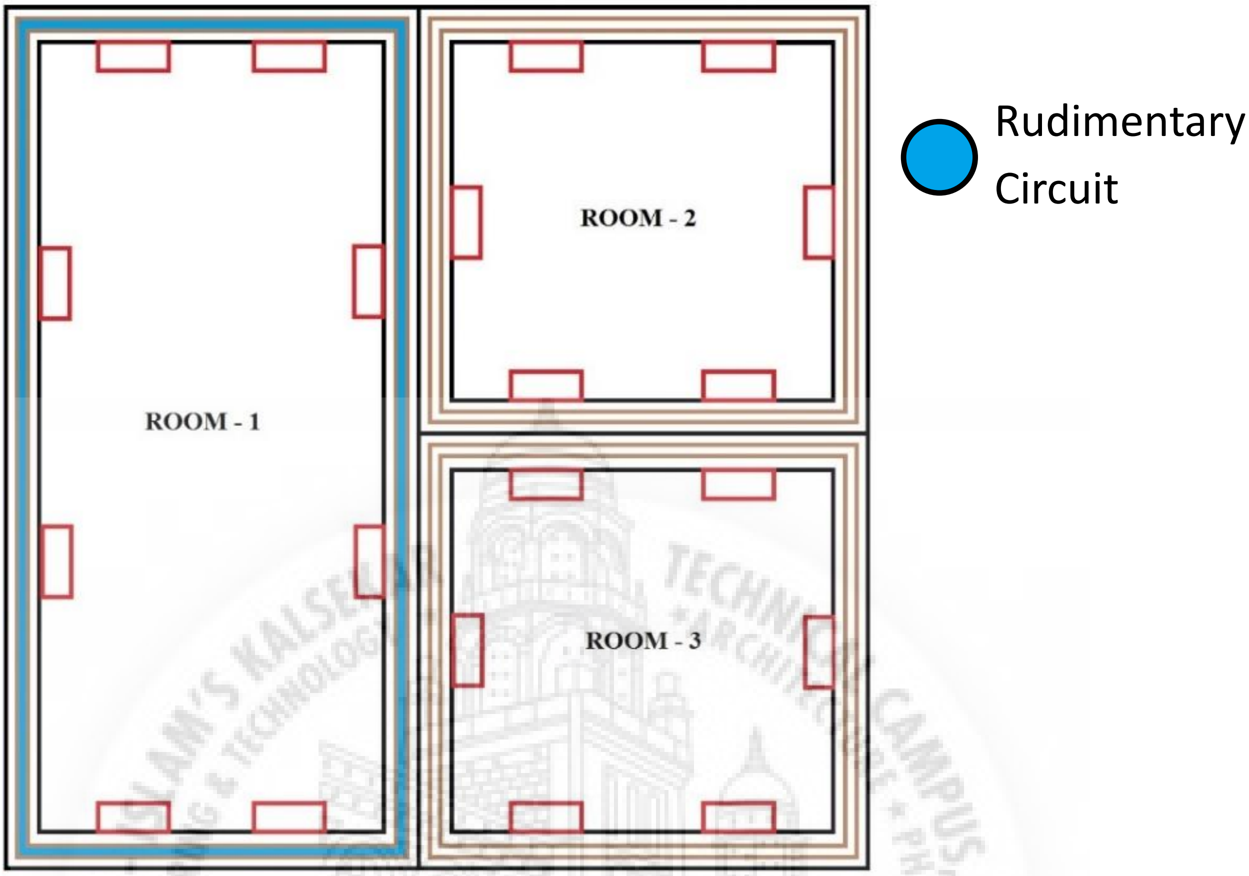


Fig 1.2: Room Layout Rudimentary Circuit Refrigerant Flow, Condition 1

1.4: Condition 2

This condition details if the user decides to turn on the evaporators of any two rooms. In this case, the controlling electronic circuit will signal the solenoid values of the first storage tank to open. That will lead to the flow of refrigerant from the storage tank into the rudimentary circuit followed by the opening of the respected room's solenoid values.

Thus, the increased amount of refrigerant will flow into two rooms to gain the required room temperature. Note that only one storage tank has opened here to release the refrigerant for one room.

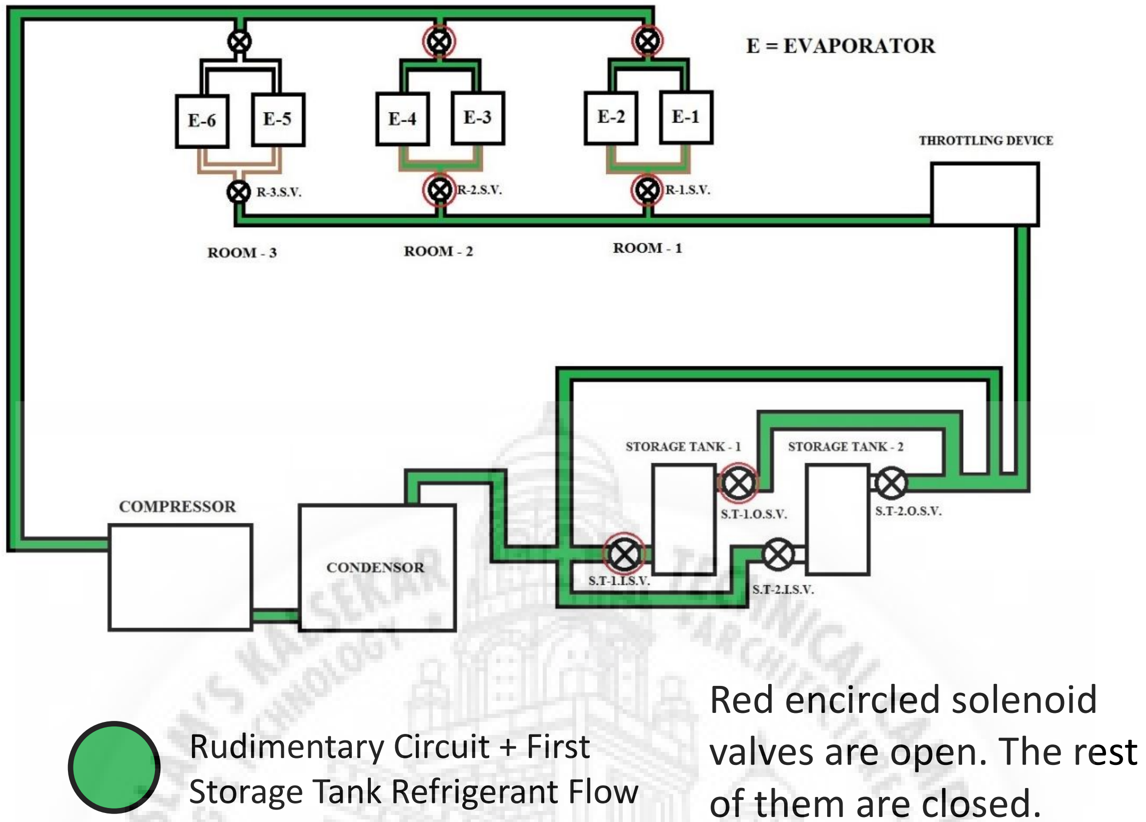


Fig 1.3: Rudimentary Circuit Refrigerant Flow, Condition 2

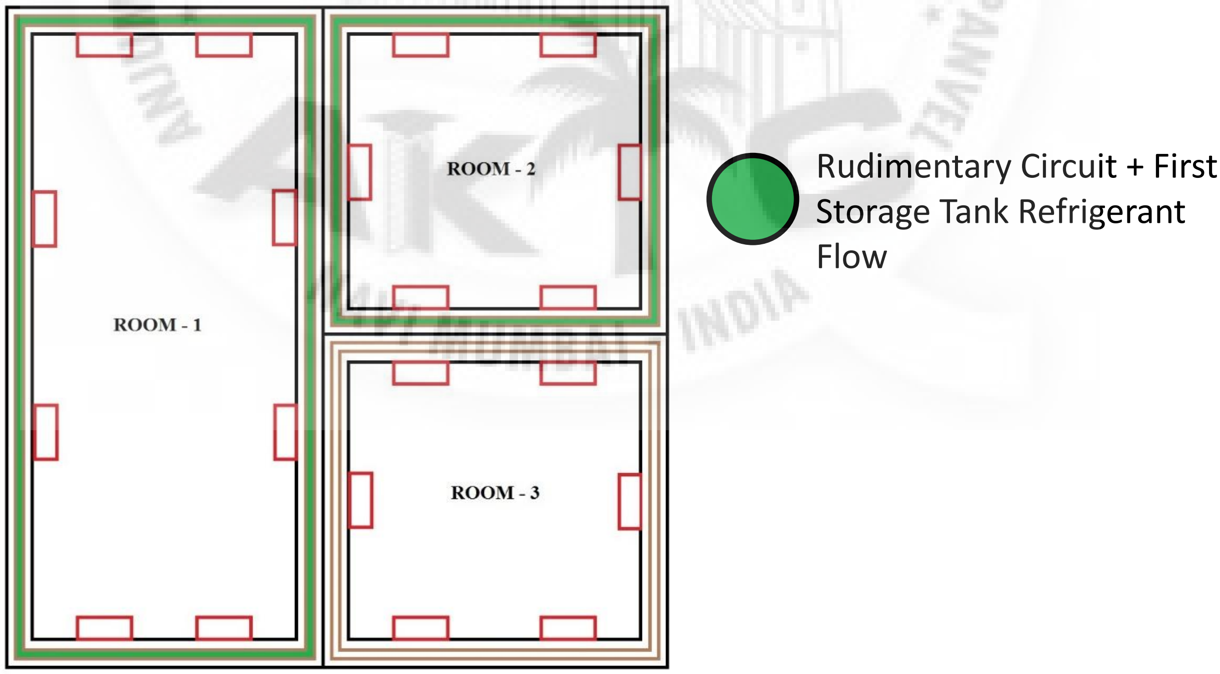


Fig 1.4: Room Layout Rudimentary Circuit Refrigerant Flow, Condition 2

1.5: Condition 3

This condition details if the user decides to turn on the evaporators of all three rooms. In this case, the controlling electronic circuit will signal the solenoid values of both the storage tanks to open. That will lead to the flow of refrigerant from both the storage tanks into the rudimentary circuit followed by the opening of all room's solenoid values.

Thus, the increased amount of refrigerant will flow into all three rooms to gain the required room temperature. Note that both the storage tanks have opened here to release the refrigerant for two rooms.

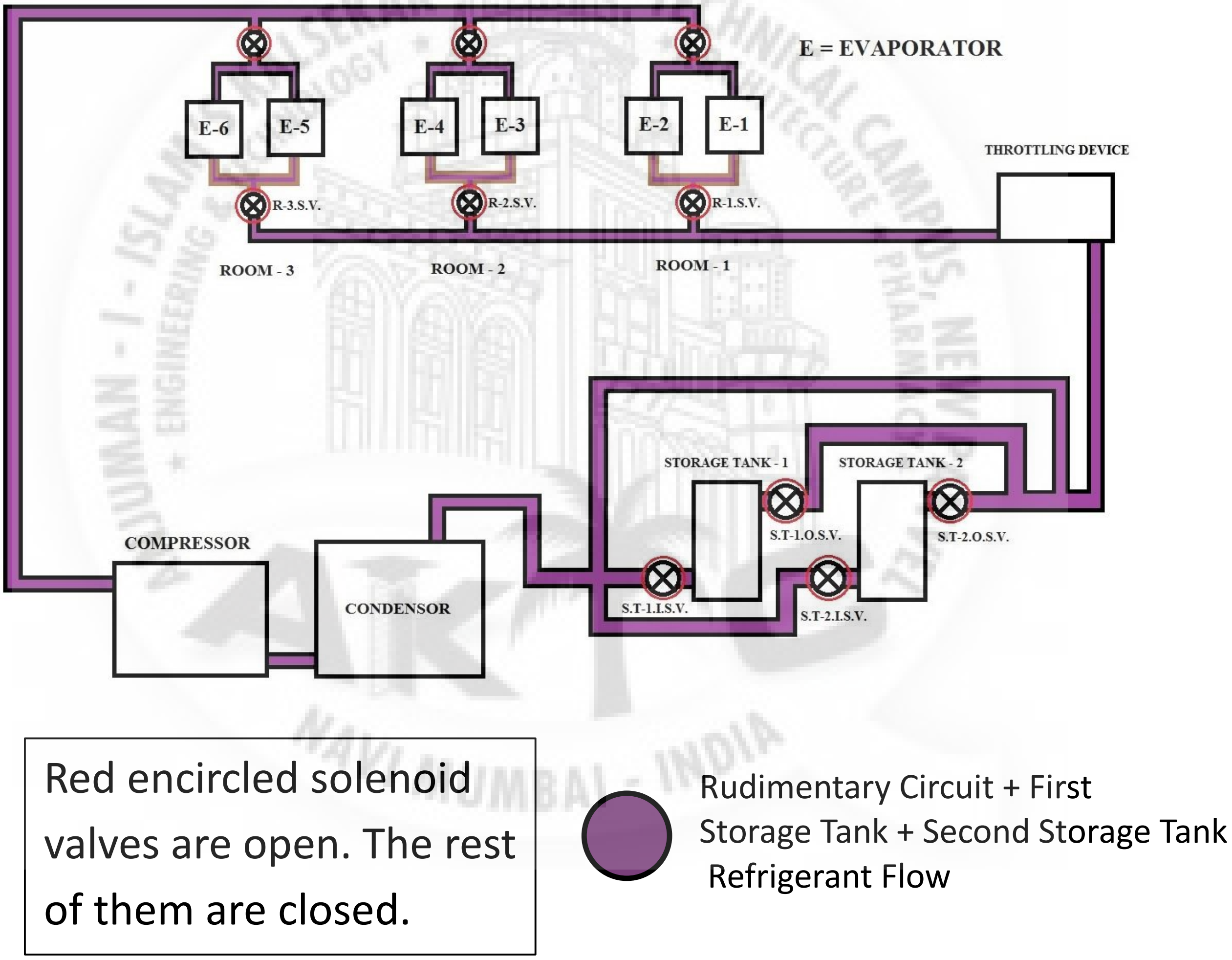


Fig 1.5: Rudimentary Circuit Refrigerant Flow, Condition 3

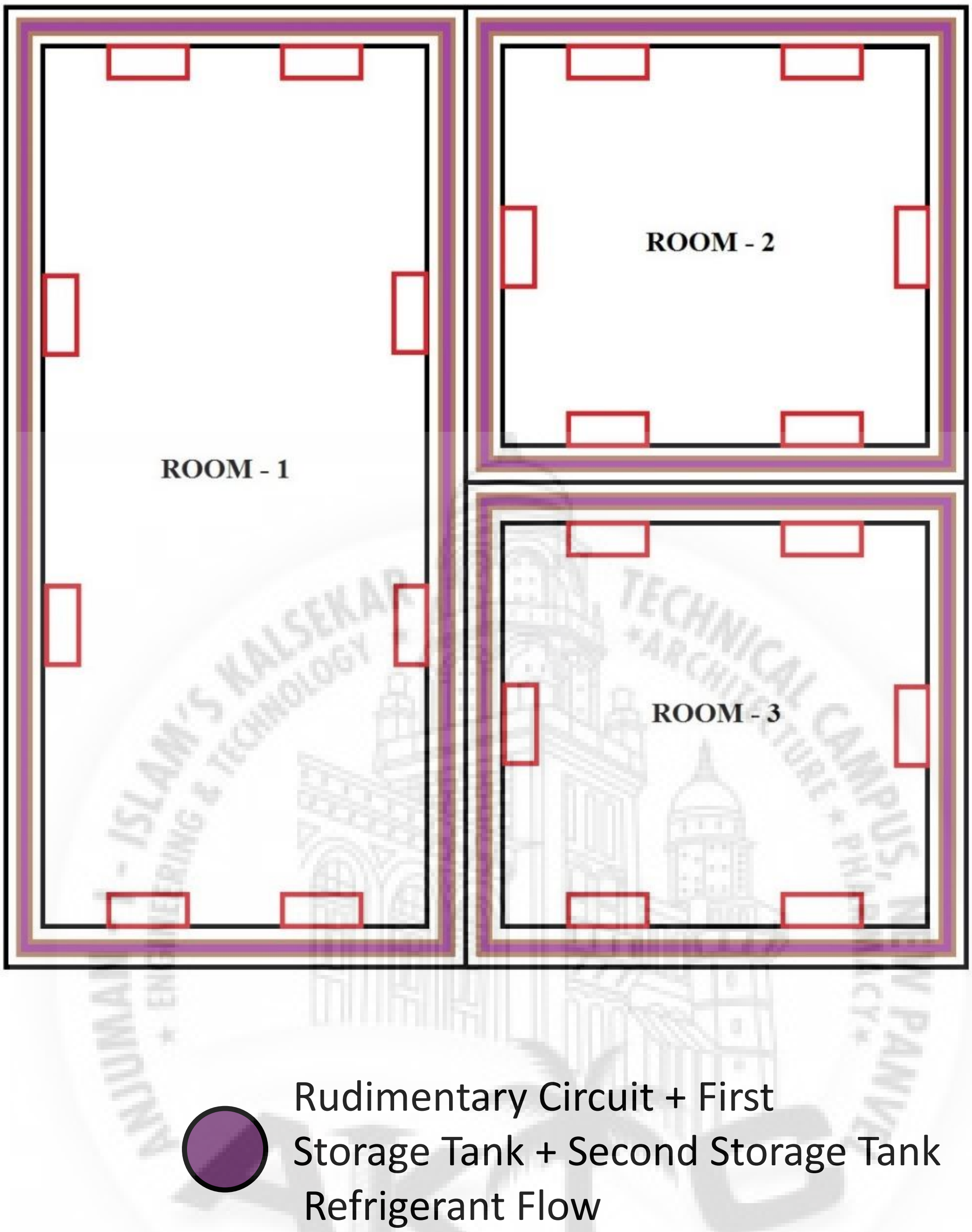


Fig 1.6: Room Layout Rudimentary Circuit Refrigerant Flow, Condition 3

CHAPTER 2

LITERATURE SURVEY

Literature Survey 1:

The author has offered a practical, global technique to analyzing the functionality of known small air-conditioning installations in residences in the Reunion region in this paper. This tropical region hopes to be self-sufficient in electric power. This technique is based on a statistical tool and sophisticated simulations of dwellings with air conditioners. The simulations are centered on the kernel computation Energy Plus, which takes into account the building cover, a programed explanation, and the users' methods.

They also take into account the region's climatic conditions and provide an estimate of the region's annual electric power demand for air conditioning. This comprehensive assessment aids in the determination of an energy label for the entire system. An analysis technique is frequently recommended in conjunction with the device, aiding an auditor in determining help to improve the building envelope as well as to set up and maintain the database.

Literature Survey 2:

This article investigated the energy consumption of RAC under a variety of heat-load circumstances and activities. Specific processes for 87 RAC units were deleted from many energy utilization figures. With outdoor temperatures changing by 5 _C, the data on person operations was separated into two groups: moderate- and severe-load conditions. Individual process durations were known to be shorter in mild-load settings than in severe-load scenarios, reflecting a considerable shift in consumer behavior.

Common energy reductions of 40% were reported when specific operating durations were lowered by 20%. A portion of this reduction was due to a reduction in duration; the rest came from changes in RAC physical effectiveness, which is affected by outdoor temperature and heating/cooling load. When person procedure stays were reduced by more than 20% during heating or by more than 26% during chilling, the time-saving advantage outweighed the physical-efficiency impact.

Literature Survey 3:

In this paper, the author looked at how Vietnamese customers value the energy efficiency of air conditioners using the hedonic cost model. Author believe that the energy efficiency of air conditioners in the Vietnamese market will be comparable to that of air conditioners in Japan. The payback period is then calculated by dividing the capital price by the annual electrical power cost savings to increase energy efficiency. Author show that the initial investment cost can be recouped in a short amount of time. In order to demonstrate how Vietnamese customers, appreciate energy efficiency spending, author calculate the implied reduced pricing rate during acquisition.

The implicit price cut pricing in Vietnam's air conditioning unit market is substantially higher than the prices reported in studies on industrialized countries around the world, according to the author. As a result, consumers in developing countries place a lower value on energy efficiency than consumers in rapidly growing countries, despite the fact that purchasing energy-efficient home appliances allows them to save significant amounts of money.

CHAPTER 3

METHODOLOGY

3.1: Design Methodology

In this project, to obtain various data related to stress and thermal analysis of different components of the setup, we have followed virtual methods. All data has been retrieved by using software analysis.

The methodology that is followed to attain the research objectives is divided into the following work phases:

- Design the complete system virtually using multiple CAD software.
- Perform a diverse of analysis onto the system such as Stress, thermal, determine its stability, etc.
- Create a virtual room depicting an apartment with fundamental parameters.
- To install the respective system into the virtual apartment.
- Perform a complete Thermal analysis of the virtual apartment to achieve the efficiency of the air conditioning system.

Software used for different modelling and analysis purposes are as follows:

- Inventor
- Solidwork
- Ansys

3.2: Design Procedure

The steps to designing air conditioning system are as follows:

3.2.1: The System's Requirements

Understanding the specifications is important, and it should be addressed with the organization before the system is designed.

3.2.2: Structure Selection

The system's arrangement must be assumed while keeping some constraints in mind, such as space, efficiency, and cost. The location of the inlet and outlet pipes, as well as the fan, should be determined based on this.

3.2.3: Content Selection

Material selection is critical in heat exchanger or condenser design because it has a direct impact on performance and cost. The thermal conductivity of the material should be considered when choosing a tube material.

3.2.4: Design Fundamentals

Calculating the heat transfer rate, uncertain temperatures, and mass flow rate are all part of the basic design.

CHAPTER 4

PROJECT

4.1: Members and Capabilities

MEMBER	TASK
KHAN FAISAL NADIM ZAHIRUDDIN	Compressor Design, Calculation, Design Of Room Layout, Analysis, Etc.
MULLA MUSTAQUIM ISMAIL	Evaporator Design, Calculation, Selection Of Different Air Conditioning Components From Danfros Coolselector, Etc.
KHALIFA HASNAIN AKHTAR	Condenser Design, Calculation, Analysis, Etc.
MAKNOJIA MOHAMMAD UMAR RIZWAN	Storage Tank Design, Calculation, Etc.

4.2: Roles and Responsibilities

During designing of compressor following points should be undertaken

Compressor			
Sr.no.	Parameter	unit	value
1	Compressor Type		
2	Capacity	Ton	
3	Motor Speed	RPM	
4	Motor Power Consumption	kW	
5	Dimensions	mm	
6	Suction Line Tube Diameter	mm	
7	Suction Line Tube Thickness	mm	
8	Discharge Line Tube Diameter	mm	
9	Discharge Line Tube Thickness	mm	
10	Suction Pressure	N/mm^2	
11	Discharge Pressure	N/mm^2	
12	Suction Line Refrigerant Temperature	Degree Celcius	
13	Suction Line Refrigerant Phase	Liquid/Gas	
14	Discharge Line Refrigerant Temperature	Degree Celcius	
15	Discharge Line Refrigerant Phase	Liquid/Gas	

Fig 4.1: Roles and Responsibilities (Design of Compressor)

During designing of condenser following points should be undertaken

Condensor			
Sr.no.	**Parameter**	**unit**	**valve**
1	Capacity	Ton	
2	Dimensions	mm	
3	Discharge Line Tube Diameter	mm	
4	Discharge Line Tube Thickness	mm	
5	Vacuum Isolated Liquid Line Inner Tube Diameter	mm	
6	Vacuum Isolated Liquid Line Inner Tube Thickness	mm	
7	Discharge Line Pressure	N/mm^2	
8	V.I. Liquid Line Pressure	N/mm^2	
9	Discharge Line Refrigerant Temperature	Degree Celcius	
10	Discharge Line Refrigerant Phase	Liquid/Gas	
11	V.I. Liquid Line Refrigerant Temperature	Degree Celcius	
12	V.I. Liquid Line Refrigerant Phase	Liquid/Gas	
13	Fan Dimensions	mm	
14	Air Flow From Fan	m/s	
15	Inlet Air Flow Temperature	Degree Celcius	
16	Outlet Air Flow Temperature	Degree Celcius	
17	Fan/Motor Speed	RPM	
18	Motor Power Consumption	kW	
19	Condensor Coil Length	mm	
20	Condensor Coil Shape		
21	Condensor Coil Diameter	mm	
22	Condensor Coil Thickness	mm	

Fig 4.2: Roles and Responsibilities (Design of Condenser)

During designing of storage tank following points should be undertaken

Storage Tank			
Sr.no.	Parameter	Unit	Value
1	Shape		
2	Inner Shell Dimensions	mm	
3	Outer Shell Dimensions	mm	
4	Inner Shell Capacity	litres	
5	Inner Shell Thickness	mm	
6	Inner Shell Threshold Pressure	N/mm^2	
7	V.I. Liquid Inlet Line Pressure	N/mm^2	
8	V.I. Liquid Outlet Line Pressure	N/mm^2	
9	V.I. Liquid Inlet Line Diameter	mm	
10	V.I. Liquid Inlet Line Thickness	mm	
11	V.I. Liquid Outlet Line Diameter	mm	
12	V.I. Liquid Outlet Line Thickness	mm	
13	V.I. Liquid Inlet Line Refrigerant Phase	Liquid/Gas	
14	V.I. Liquid Outlet Line Refrigerant Phase	Liquid/Gas	
15	Static Refrigerant Pressure on Inner Shell	N/mm^2	
16	Static Refrigerant Phase in Inner Shell	Liquid/Gas	
17	Static Refrigerant Temperature in Inner Shell	Degree Celcius	
18	Inlet Valve Position	mm, theta	
19	Outlet Valve Position	mm, theta	
20	Inner to Outer Shell Offset	mm	
21	Vacuum Intensity between the Shells	microns	

Note: The Storage Tank consists of two shells, i.e., Inner Shell and Outer Shell. One encapsulated into another providing Vacuum between them to avoid exchange of energy.

Fig 4.3: Roles and Responsibilities (Design of Storage Tank)

During designing of evaporator following points should be undertaken

Evaporator			
Sr.no.	Parameter	Unit	Value
1	Dimensions	mm	
2	Capacity	Ton	
3	Motor Power Consumption	kW	
4	V.I. Liquid Inlet Line Pressure	N/mm^2	
5	Suction Outlet Line Pressure	N/mm^2	
6	V.I. Liquid Inlet Line Diameter	mm	
7	V.I. Liquid Inlet Line Thickness	mm	
8	Suction Outlet Line Diameter	mm	
9	Suction Outlet Line Thickness	mm	
10	Inlet Refrigerant Temperature	Degree Celcius	
11	Outlet Refrigerant Temperature	Degree Celcius	
12	Inlet Refrigerant Phase	Liquid/Gas	
13	Outlet Refrigerant Phase	Liquid/Gas	
14	Blower Fan Dimensions	mm	
15	Air Flow through Blower Fan	m/s	
16	Inlet Air Flow Temperature	Degree Celcius	
17	Outlet Air Flow Temperature	Degree Celcius	
18	Blower Fan Speed	RPM	
19	Evaporator Coil Tube length	mm	
20	Evaporator Coil Tube Shape		
21	Evaporator Coil Tube Inlet Diameter	mm	
22	Evaporator Coil Tube Outlet Diamete	mm	
23	Evaporator Coil Tube Thickness	mm	
24	Inlet Refrigerant Phase	Liquid/Gas	
25	Outlet Refrigerant Phase	Liquid/Gas	

Fig 4.4: Roles and Responsibilities (Design of Evaporator)

There are three Types of Lines are classified as:
1) **Suction Line:**
Connects Evaporator to Compressor.
2) **Discharge Line:**
Connects Compressor to Condensor.
3) **Liquid line:**
Connects Condensor to the Expansion Valve which attaches with the Evaporator.

Basically, the **Vacuum Isolated Liquid Line** will **replace Liquid Line** which will connect **Condensor to Storage Tank** and **Storage Tank to Expansion Valve and the Evaporators**.

Sr.no.	Parameter	Suction Line		Discharge Line		Vacuum Isolated Liquid Line			
						Inner Tube		Outer Tube	
		Unit	Value	Unit	Value	Unit	Value	Unit	Value
1	Material								
2	Length	mm		mm		mm		mm	
3	Thickness	mm		mm		mm		mm	
4	Diameter	mm		mm		mm		mm	
5	Pressure Range	N/mm^2		N/mm^2		N/mm^2		X	X
6	Refrigerant Temperature	Degree Celcius		Degree Celcius		Degree Celcius		X	X
7	Refrigerant Phase	Liquid/ Gas		Liquid/ Gas		Liquid/ Gas		X	X
8	Vacuum Intensity between Inner Tube and Outer Tube	X	X	X	X	Unit		Value	
		X	X	X	X	Microns			
		X	X	X	X				

Fig 4.5: Roles and Responsibilities (Design of Suction line, Discharge line, Liquid line)

During designing of room layout following points should be undertaken

Virtual Apartment				
	Room 1		Room 2	
Each Room Parameter	Unit	Value	Unit	Value
Height	mm		mm	
Length	mm		mm	
Wall Thickness	mm		mm	
Area	mm^2		mm^2	
Average Room Temperature	Degree Celcius		Degree Celcius	
Required Temperature Range	Degree Celcius		Degree Celcius	

Fig 4.6: Roles and Responsibilities (Design of Room)

4.3: Expectations and Constraints

We addressed each member's schedule prior to the start of the project and created a project timeline based on that information. While working on the project, we were bound by some restrictions, such as college rules prohibiting us from skipping lectures and a time limit for issuing labs. Since some of us had busy schedules, we were unable to devote as much time to the project as we would have liked.

4.4: Project Management Approach

Our guide led the project flawlessly, and he dispersed the work according to everyone's skill level. We all did our jobs according to the guide's instructions and completed them successfully.

4.5: Economic Analysis of the Project

Since we want to make this project virtually by using some software. Therefore, there will be no cost related to manufacturing the components of the setup. There will be only cost required to print this thesis. All other expenses like withdrawing subscription of some paper can also be included. But if someone wants to fabricate it by referring our project calculation and results then the cost will be comprises related to following components:

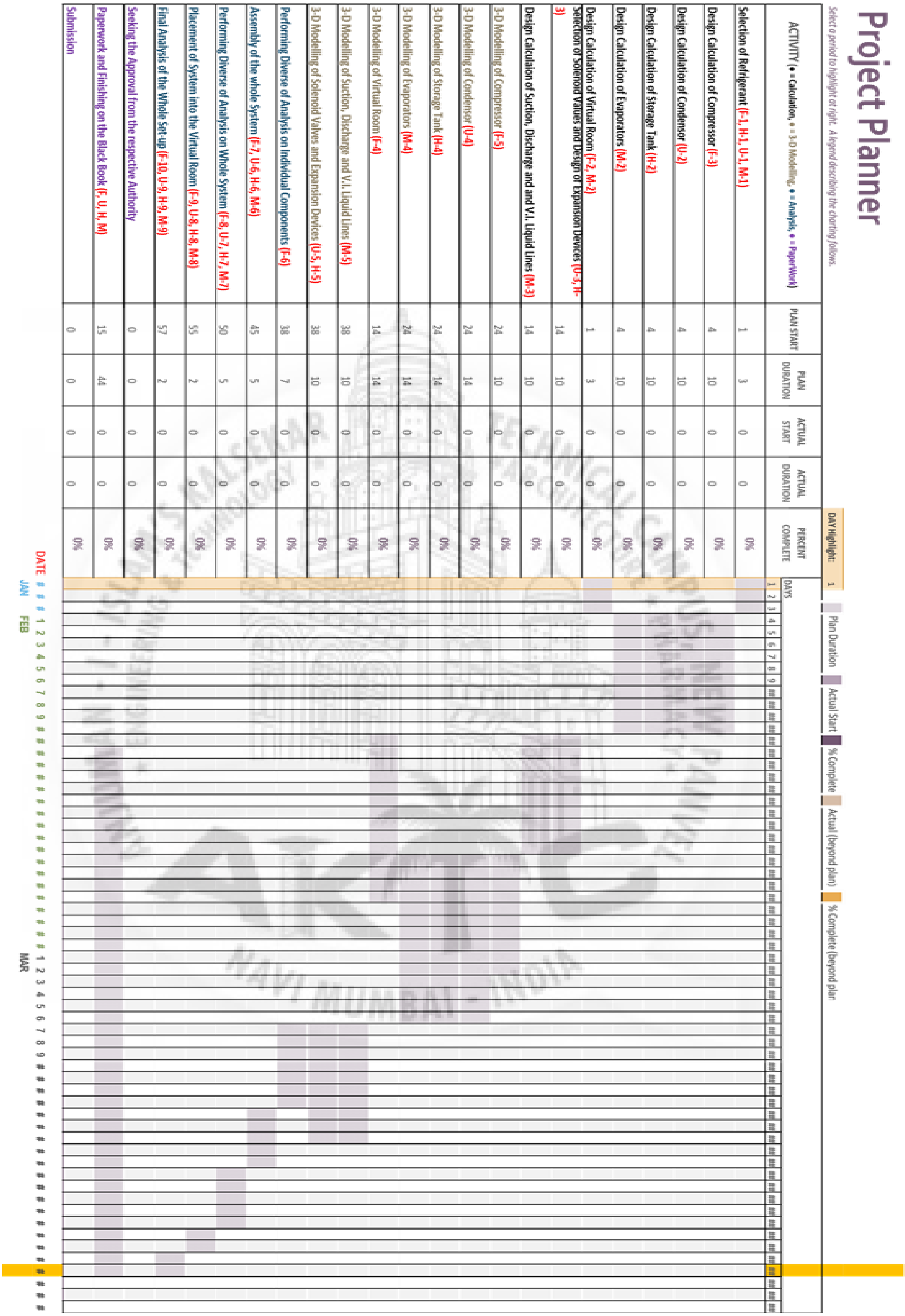
Compressor

Condenser

Evaporator assemblies

Setup installments

4.6: Project Timeline or Gantt Chart



ACTIVITY (■ = Calculation, ■ = 3-D Modelling, ■ = Analysis, ■ = PaperWork)	PLAN START	PLAN DURATION	ACTUAL START	ACTUAL DURATION	PERCENT COMPLETE
Selection of Refrigerant (F-1, H-1, U-1, M-1)	1	3	0	0	0%
Design Calculation of Compressor (F-3)	4	10	0	0	0%
Design Calculation of Condensor (U-2)	4	10	0	0	0%
Design Calculation of Storage Tank (H-2)	4	10	0	0	0%
Design Calculation of Evaporators (M-2)	4	10	0	0	0%
Design Calculation of Virtual Room (F-2, M-2)	1	3	0	0	0%
Selection of Solenoid Values and Design of Expansion Devices (U-3, H-3)	14	10	0	0	0%
Design Calculaion of Suction, Discharge and and V.I. Liquid Lines (M-3)	14	10	0	0	0%
3-D Modelling of Compressor (F-5)	24	10	0	0	0%
3-D Modelling of Condensor (U-4)	24	14	0	0	0%
3-D Modelling of Storage Tank (H-4)	24	14	0	0	0%
3-D Modelling of Evaporators (M-4)	24	14	0	0	0%
3-D Modelling of Virtual Room (F-4)	14	14	0	0	0%
3-D Modelling of Suction, Discharge and V.I. Liquid Lines (M-5)	38	10	0	0	0%
3-D Modelling of Solenoid Valves and Expansion Devices (U-5, H-5)	38	10	0	0	0%
Performing Diverse of Analysis on Individual Components (F-6)	38	7	0	0	0%
Assembly of the whole System (F-7, U-6, H-6, M-6)	45	5	0	0	0%
Performing Diverse of Analysis on Whole System (F-8, U-7, H-7, M-7)	50	5	0	0	0%
Placement of System into the Virtual Room (F-9, U-8, H-8, M-8)	55	2	0	0	0%
Final Analysis of the Whole Set-up (F-10, U-9, H-9, M-9)	57	2	0	0	0%
Seeking the Approval from the respective Authority	0	0	0	0	0%
Paperwork and Finishing on the Black Book (F, U, H, M)	15	44	0	0	0%
Submission	0	0	0	0	0%

Fig 4.7: Gantt Chart

CHAPTER 5

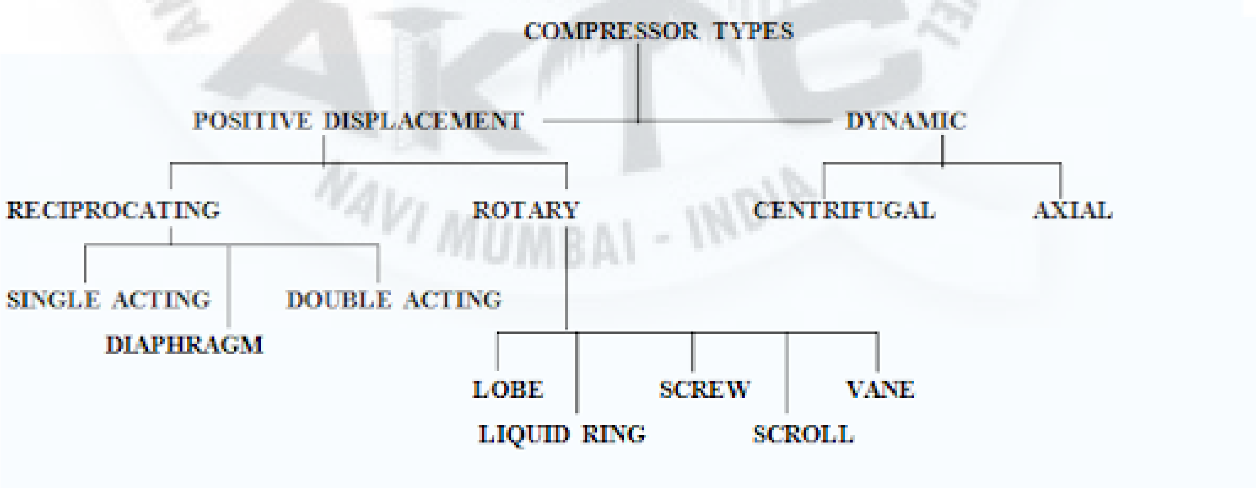
COMPRESSOR

5.1: About Compressor

One of the utmost central components of air conditioner is the "compressor". The compressor benefits in the cooling process and it also confirms that the machine functions efficiently and continuously.

A refrigerant compressor is a mechanism and it compresses and advances the pressure of the vapour refrigerant from the evaporator in such a way that the subsequent saturation temperature is higher than the cooling or freezing medium. The compressor also circulates the refrigerant in the refrigerating device on a continuous basis. Since refrigeration compression imposes some work, a compressor must be powered by some kind of prime mover.

5.2: Types of Compressor



The general types of air conditioning compressor which are used nowadays include:

5.2.1: Reciprocating Air Conditioner Compressor

The reciprocating air conditioner compressor has the utmost experience and is the most comparable to refrigeration compressors. By going up and down within a cylinder, a piston compresses the air. The refrigerant gas is sucked in by the vacuum effect produced by this motion. Although a reciprocating AC can experience failures due to piston wear, its ability to use up to eight cylinders makes it a highly efficient machine.

Fig 5.1: Reciprocating Air Conditioner Compressor

5.2.2: Scroll Air Conditioning Compressor

Scroll compressor, which is a new development that comprises a specific loop that serves as a unit's base. The refrigerant pass and flows in the compressor and driven toward the middle by a secondary coil rotating across the principal scroll. Scroll compressor is noticeably quite efficient because it has less moving parts.

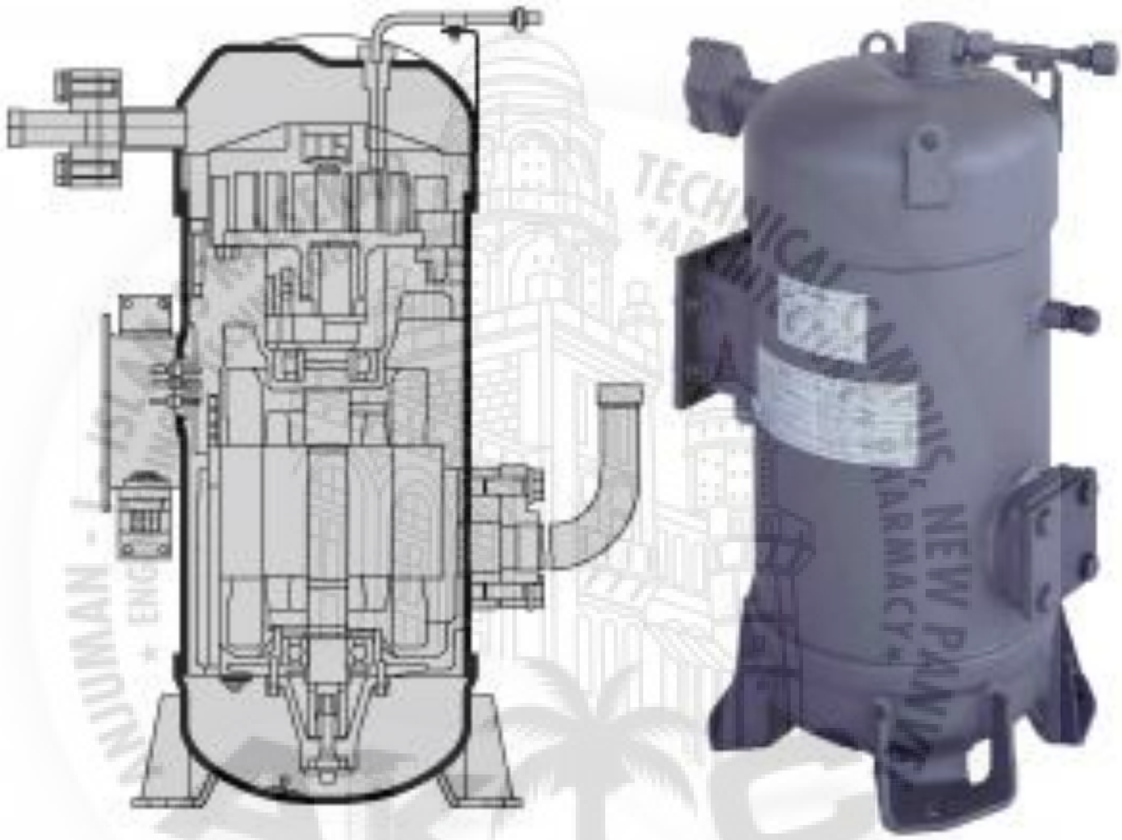


Fig 5.2: Scroll Air Conditioner Compressor

5.2.3: Screw Air Conditioning Compressor

Screw compressors, which are usually used in huge commercial or marketable buildings that need a large proportion of air circulation and cooling or chilling. A couple of interconnected helical rotors drive air from one place to the other place in this unit. Screw compressors, which are the utmost dependable plus powerful compressor in the market, but they are ineffective for smaller jobs.

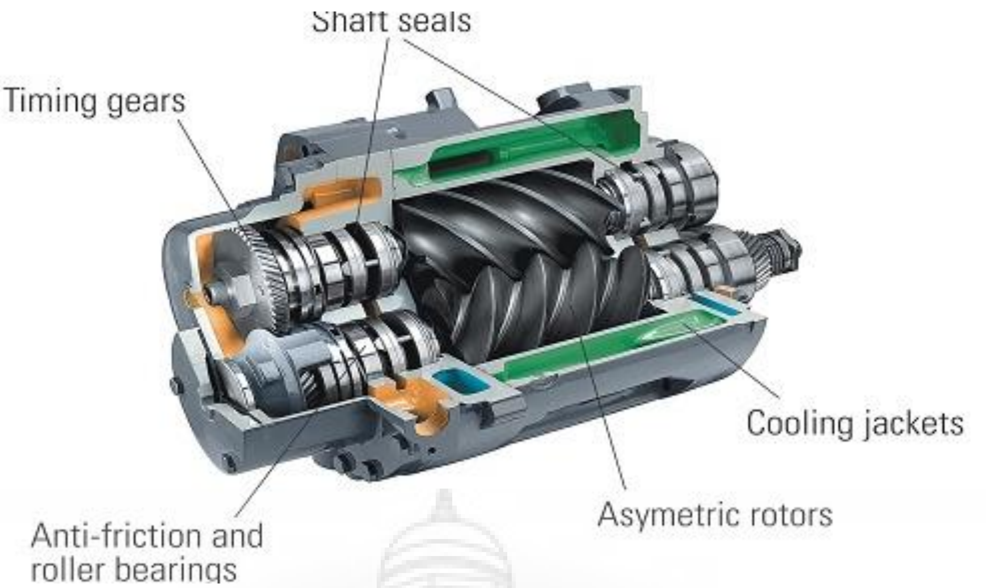


Fig 5.3: Screw Air Conditioner Compressor

5.2.4: Rotary Air Conditioning Compressor

When operating noise is a problem, rotary compressors are the best choice. They are silent, have a small footprint, and are less susceptible to vibration than other compressors. A bladed shaft rotates inside a graduated cylinder in the machine to simultaneously push and compress refrigerant.

Fig 5.4: Rotary Air Conditioner Compressor

5.2.5: Centrifugal Air Conditioning Compressor

The largest HVAC systems include a centrifugal AC compressor. The refrigerant is drawn in by centrifugal force, as the name implies. An impeller is then used to compress the gas. Centrifugal compressors are among the largest and costliest due to their planned use.

Fig 5.5: Centrifugal Air Conditioner Compressor

5.3: Parts of A Compressor

The cylinder, crankshaft, piston, and piston rod are all standard components in almost all types of compressors.

The compressor valve is one of the most critical components of any compressor because it controls the circulation of refrigerant vapour via the machine.

There are some obligatory parts to retain a compressor valve working properly:

- Ported Plates
- Wafer Plates
- Radius Rings

- Locknuts
- Bullets
- Damping and Cushion Plates
- Studs
- Poppets
- Valve Plates
- Spring Plates
- Centre Bolts

These are just a few of the many components that make up a compressor and its valve. In order to optimize safety and performance, the repair and maintenance of such a complex system should be taken seriously.

It is important to ensure that these parts are robust and long-lasting for the use of a high-capacity compressor. They demand the highest-quality compressor materials, which will vary depending on your compression requirements.

5.4: Types of Compressor Parts Materials

There are a variety of compressor materials that could be used to make the above compressor valve sections, as well as others.

5.4.1: Thermoplastic

- A polymer that softens upon heating
- Capable to be moulded into a certain shape
- Upon cooling, it hardens

5.4.2: Nylon

- Used in constructing several compressor valve parts
- Made by using polyamide
- Contains 30% glass fiber reinforced
- Hydrolysis resistant and heat stabilized material

- It's normally lubricated to improve refrigerant flow, and it's designed to help the refrigerant retain its physical properties as much as possible during the various phase changes it goes through.

5.4.3: Peek

- Also recognized as polyetheretherketone
- Contains 30% reinforced glass fibres for the purpose of strength and durability
- Noble for sterilizing things like food contact surfaces and medical devices.
- Small coefficient which is a multiplying factor for defining a particular property for improved thermal expansion
- It is ideal for use in a static compression system against a dynamic one.

5.4.4: Carbon-Peek

- A similar material but is reinforced with carbon fibers as a replacement for of glass
- Great performance thermoplastic material
- Semi crystalline
- It does not wear or break down easily
- It has a small coefficient of friction

5.4.5: MT

- MT abbreviates for 'Mid Temperature' a gas-filled nylon material
- Noble strength and heat resistance
- Great durability

5.5: Selecting Material

Each of these and other compressor materials has its own set of advantages and disadvantages, so it's best to obtain professional advice on which materials would work best for the type of compression needed.

The information above can help provide a basic rundown of these key components, but since they are all part of a complex testing framework with many properties, further analysis is likely to be needed.

5.6: Compressor Position

The compressor is located in the outdoor air conditioning unit, which can be found in the back or side of your house. The condenser, condenser coil, and fan are also essential components of the outdoor device. A copper refrigerant tube connects the outside unit to the indoor portion of the air conditioning system. These two parts work together to absorb hot air from inside your home and convert it to cool air once they're paired.

5.7: Compressor Role

Main important part of air conditioning system is known as the compressor. Compressor enhances the progress by drawing in cold, small pressure related to refrigerant gas starting inside. Primary intention of the compressor during cycle is to compress the refrigerant, growing the temperature along with the pressure until it leavings as a warm and great pressure gas.

5.8: Compressor Maintenance or Prevention

The compressor must be kept in good working order for the air conditioner to operate properly. Do not, however, try to maintain this part on your own. Your HVAC technician will inspect the compressor for any apparent damage or malfunction during a service visit. Your service technician can also inspect the compressor pads to ensure the device is free of any electrical issues that could damage the compressor.

5.9: Compressor Malfunction

Compressor has a lot of moving parts and is prone to breaking. If the compressor fails for some reason, the device can make noises, provide inadequate cooling, or start up slowly.

5.9.1: Sounds coming from the compressor:

- If a loose component is inside the compressor, you can hear banging or clanking noises
- Bubbling and hissing may suggest a refrigerant leak in the compressor
- Keep in mind that compressors are prone to making a brief noise when they first start up

5.9.2: Inadequate cooling:

- Loose or worn compressor
- Air conditioner will not adequately cool your house

5.9.3: Hard starting:

- Compressor is having trouble turning on or off
- May be the result of an electrical issue with the air conditioner

A faulty compressor may also effect the outdoor component resulting in overheat, the compressor to detonation, and also the air conditioning system to stop working altogether.

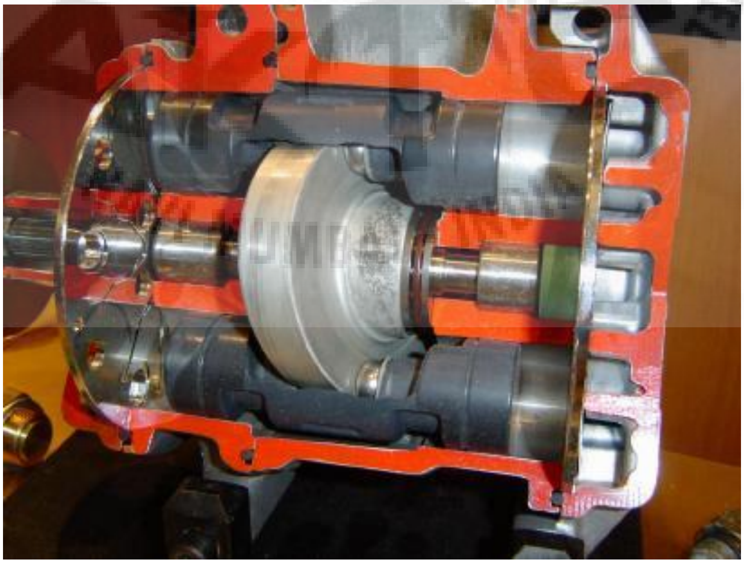
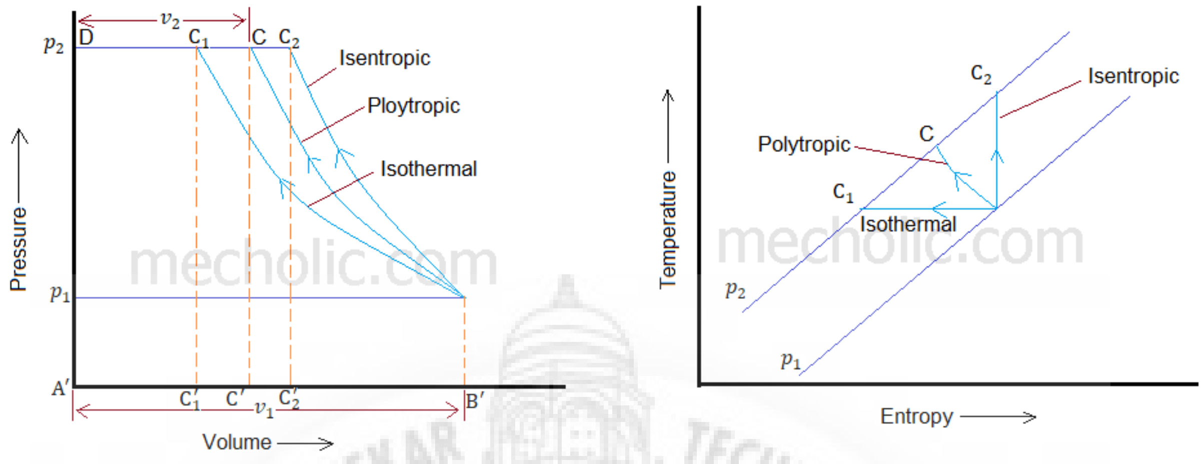


Fig 5.6: Failure of compressor

5.10: Reciprocating Compressor Work



(a) p-v Diagram (b) T-s diagram

Suction, injection or compression, and discharge of compressed fluid are the three operations of a reciprocating compressor.

In a reciprocating compressor cycle, the function of the piston during the suction of fluid/ refrigerant, the work of the piston during the compression of fluid, and the work of the piston during the discharge of compressed fluid are all included. The work performed by a reciprocating compressor is equivalent to the work performed by the compressor during compression and discharge minus the work performed during fluid suction.

Consider

- single stage
- single acting reciprocating compressor
- No clearance volume

Let

- p_1= Suction pressure (before compression)
- V_1 = Suction volume
- T_1= Suction temperature
- p2, V_2, T_2 as corresponding pressure, volume, and temperature after compression.
- r = compression ratio (p_1/p_2)

Work done (Isothermal compression)

Line AB = suction of fluid,

Area within AB (ABB'A') = work done during cycle of the suction process

$W_1 = P_1 V_1$

Work done during the process of compression;

W_2 = Area of BC1C1'B'

$$W_2 = p_1 v_1 \log_e \left(\frac{v_1}{v_2}\right)$$

Work done during the process of discharge;

W_3= Area C1DA'C1'

$$W_3 = P_2 V_2$$

Work done obtained by compressor through the one successful or complete cycle or process of operation;

$W = W_3 + W_2 - W_1$

$$W = p_2 v_2 + p_1 v_1 \log_e \left(\frac{v_1}{v_2}\right) - p_1 v_1$$

Since

$P_1 V_1 = P_2 V_2$

$$W = p_1 v_1 \log_e \left(\frac{v_1}{v_2}\right)$$

$$= 2.3\, p_1 v_1 \log \left(\frac{v_1}{v_2}\right)$$

But

$P_1 V_1 = mRT_1$

$$\frac{v_1}{v_2} = \frac{p_1}{p_2} = r$$

$$W = 2.3\, mRT_1 \log r$$

Work done (Polytropic compression i.e. PV^n = constant)

The work done in the process of the compression = area under BCC'B'

$$W_2 = \frac{p_2v_2 - p_1v_1}{n-1}$$

Work done;

W= W_3+W_2-W_1

$$W = p_2v_2 + \frac{p_2v_2 - p_1v_1}{n-1} - p_1v_1$$

$$= \frac{(n-1)p_2v_2 + p_2v_2 - p_1v_1 - (n-1)p_1v_1}{n-1}$$

$$= \frac{n}{(n-1)}(p_2v_2 - p_1v_1)$$

$$= \frac{n}{(n-1)}p_1v_1\left(\frac{p_2v_2}{p_1v_1} - 1\right)$$

For polytropic compression

Let

n = ploytropic index

$$P1(V1)^{n} = P2(V2)^{n}$$

$$\frac{v_2}{v_1} = \left(\frac{p_1}{p_2}\right)^{\frac{1}{n}}$$

Putting the values of V2/V1

$$W = \frac{n}{(n-1)}p_1v_1\left(\frac{p_2}{p_1}\left(\frac{p_1}{p_2}\right)^{\frac{1}{n}} - 1\right)$$

$$= \frac{n}{(n-1)}mRT_1\left(\frac{p_2}{p_1}\left(\frac{p_2}{p_1}\right)^{\frac{-1}{n}} - 1\right)$$

$$= \frac{n}{(n-1)}mRT_1\left(\left(\frac{p_2}{p_1}\right)^{\frac{-1}{n}+1} - 1\right)$$

$$= \frac{n}{(n-1)} mRT_1 \left(\left(\frac{p_2}{p_1} \right)^{\frac{n-1}{n}} - 1 \right)$$

But

$$\left(\frac{p_2}{p_1} \right)^{\frac{n-1}{n}} = \frac{T_2}{T_1}$$

The above work done equation can be modified as

$$= \frac{n}{(n-1)} mRT_1 \left(\frac{T_2}{T_1} - 1 \right)$$

$$W = \frac{n}{(n-1)} mR(T_2 - T_1)$$

Work done (Isentropic compression)

The curve BC2 = isentropic compression.

Work done in the process of isentropic compression is almost similar to the work done in the process of polytropic compression

$$W = \frac{\gamma}{(\gamma-1)} mR(T_2 - T_1)$$

Here

γ = isentropic index

We know that

$$\gamma = \frac{c_p}{c_v}$$

And

$$C_p - C_v = R = C_p \frac{\gamma}{(\gamma-1)}$$

C_p and C_v = specific heats

$$W = \frac{\gamma}{\gamma-1} mC_p \left(\frac{\gamma-1}{\gamma} \right) (T_2 - T_1)$$

$$W = mC_p(T_2 - T_1)$$

5.11: Measuring Performance (Installed Air Compressors)

Air compressor's primary function can be defining as to generate compressed air via drawing in the ambient air, pressurizing or else compressing it and then releasing it keen on the compressed or pressurized air network.

Power of an air compressor is determined through its power grade and the FAD (Free Air Delivery) requirements identified by the manufacturer at the period of purchase. Though, as time passes, an onsite calculation will prove to be extremely beneficial. Following are few basic points that can help you understand how an air compressor works:

- Electrical power for compressor
- Compressed air delivering by compressor
- Pressure profile of compressor

Type	:					
n°	:	AP1610530				
P_{max}	:	8bar	–	116 psi	–	0,8 MPa
Qv	:	230,6 l/s	–	488,6 cfm	–	13,84 m³/min
P_{motor}	:	75kW	–	100 hp		
n_{motor}	:	2978 r/min				
m	:	1530 kg	–	3373 lb		
Manufacturing year :						2009

Fig 5.7: Usual air compressor nameplate

Table 5.1: Dependency of FAD (Free Air Delivery) on pressure

Working pressure				Capacity FAD			Installed motor power	
Standard		Full Feature						
bar(e)	psig	bar(e)	psig	l/s	m³/min	cfm	kW	hp
5.5	80	5.3	77	336	20.2	712	90	125
7.5	109	7.3	106	293	17.6	621	90	125
8.5	123	8.3	120	280	16.8	593	90	125
10	145	9.8	142	253	15.2	536	90	125

It is important to calculate the performance of air compressors. You can gain even more advantages by providing continuous monitoring of the compressed-air system.

Predictive maintenance is the secret to ensuring that components are serviced until they malfunction. Also, keep track of your energy intake to ensure that your investment pays off quickly. These factors, when combined with daily leak surveys, will enable you to have a safe and efficient compressed-air system.

CHAPTER 6

CONDENSER

6.1: What Is Condenser?

A condenser is a heat exchanger that uses cooling to condense a gaseous material into a liquid state. As a result, the substance's latent heat is released and transmitted to the surrounding world. The type of condenser to use is determined by the application, the gas to be condensed, and the cooling medium.

6.2: Types of Condenser

Classification of Condensers

- 1. Air-cooled Condensers
  - a. Natural convection air-cooled condensers
  - b. Forced convection air-cooled condensers
- 2. Water-Cooled Condensers
  - a. Tube-in-tube or double-tube condensers
  - b. Shell and coil condensers
  - c. Shell and tube condensers
- 3. Evaporative Condensers

6.2.1: Air Cooled Condenser

With refrigerant refusing heat to air flowing through a condenser, air is used as a cooling fluid.

(a) Natural Convection Air-Cooled Condenser

As the name suggests, natural convection is used to move air in this type of condenser. When it passes over the warm condenser tube, the cold air absorbs heat. The density of the air decreases as the temperature of the air increases. Along the hot tunnel, the lighter warm air rises and is replaced by fresh cold air. This continuous loop is known as natural convection.

(b) Forced Convection Air-Cooled Condenser

In this type of condenser, fans forcefully replace the air over the condenser tubes. This process quickly replaces warm air and boosts condenser power.

6.2.2: Water Cooled Condenser

Water absorbs the heat in these condensers, and they're popular where there's a plentiful supply of clean, low-cost water and proper water disposal.

(a) Tube-In-Tube or Double-Tube Condenser

This type of condenser, which is made consisting of a water tube inside a long refriger ant tube, allows hot vapour refrigerant to enter at top.

Water or liquid absorbs heat from refrigerant and concentrated liquid refrigerant flows towards floor.

Because refrigerant tubes are exposed to ambient air or atmosphere, natural convectio n absorbs some of heat and further transfers it to the ambient air.

(b) Shell and Coil Condensers

This type of condenser is made out of a cylindrical steel shell with several straight water tubes. Tubes are stretched into grooves in tube sheet holes to form a vapour-tight fit. The removable water boxes are fastened to the tube sheet on both ends to facilitate cleaning the condenser easier.

6.2.3: Evaporative Condensers

Evaporative condenser, which use both air and water as a condensing medium. A header sprays liquid that is water from evaporative sump of condenser over condenser coil. A fan sucks air from the bottom of the condenser and releases it from the tip at the same time.

Spray water evaporates into the air stream when it comes into touch with the condenser tube surface, and the heat required to vaporize the water is taken from the refrigerant, causing the gas to condense.

The cold water that falls into a sump is recirculated, and more water is added to make up for the shortfall caused by evaporated water. The makeup supply is controlled by a float valve in the sump, and an eliminator is installed above the spray header to keep water particles from escaping with the discharge air.

6.3: Parts of A Condenser

Generally, most of condenser are made up of following basic parts:

- Cabin
- Coil
- Fins
- Fan

Cabin

It contains a coil, fan, compressor, and other key pieces and serves as a casing for other parts.

Coil

It can be composed of copper or aluminium, although copper is the most common material since it allows for better heat transfer.

Fins

Its purpose is to divert heat away from the air conditioner, allowing the heat to dissipate more quickly.

Fan

Its purpose is to circulate and flow air through the coils and fins while also lowering the temperature of the refrigerant flowing through the coil.

6.4: Working of A Condenser

The condenser cools the refrigerant or works in the following three stages:

- Desuperheating
- Condensation
- Sub-Cooled

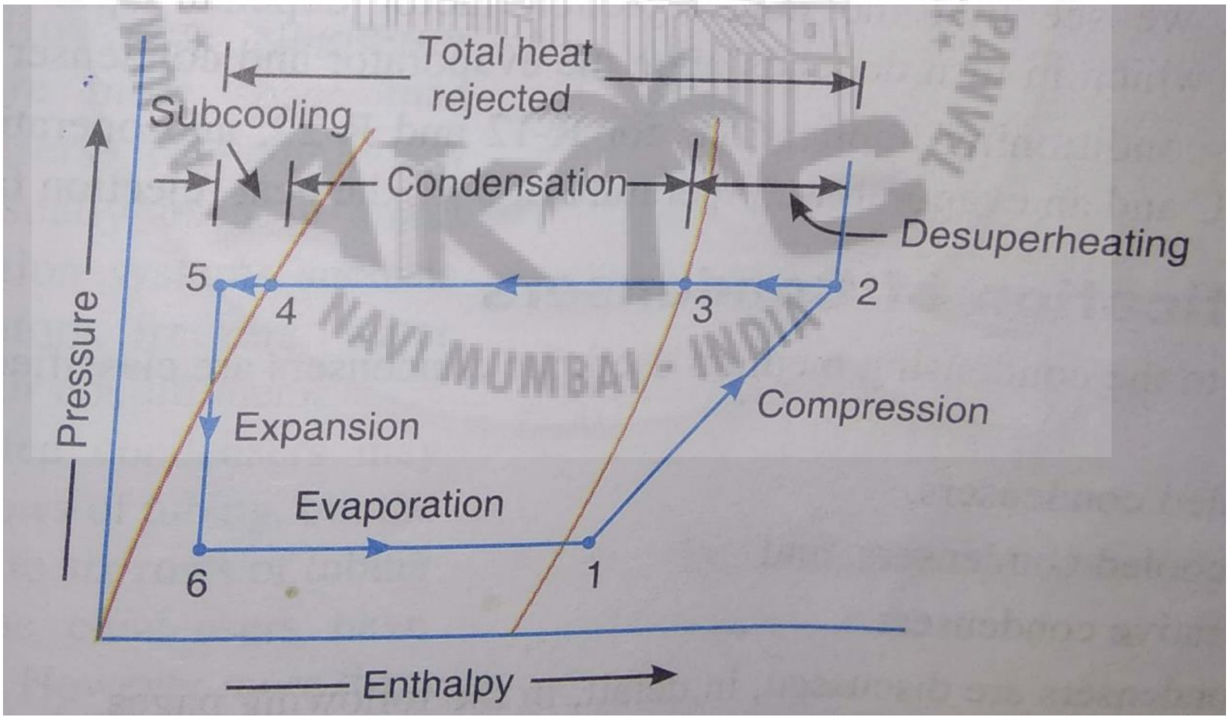


Fig 6.1: p-h diagram of a simple refrigerant system

Desuperheating

Desuperheating happens in discharge line, and first few coils of condenser and superheated vapour is cooled to saturation temperature corresponding to the refrigerant pressure. This is demonstrated by using line 2-3 in fig 6.1.

Condensation

The saturated vapour refrigerant condenses to a saturated liquid refrigerant, releasing its latent heat. Lines 3-4 demonstrate this.

Sub-Cooled

In order to enhance the refrigeration performance or effect, temperature related to liquid refrigerant result is dropped lower or below its saturation temperature. Lines 4-5 demonstrate this procedure.

6.5: Heat Rejection Factor

The heat rejection factor is defined as the load on condenser per unit of refrigeration capacity. Load on condenser is calculated as follows:

$$Qc = Refrigeration\ capacity\ (Re)\ +\ \ work\ done\ by\ compressor(W)$$

$$Qc = Re + W$$

$$HRF = \frac{Qc}{Re} = \frac{Re + W}{Re}$$

$$HRF = 1 + \frac{1}{COP}$$

It is obvious from the preceding equation that HRF is determined by the coefficient of performance, which is determined by the evaporator and condenser temperatures.

6.6: Factors Affecting the Condenser Capacity

Ability of condenser for transmission of heat or energy from a hot vapour refrigerant to path of condensing medium is referred to as condenser capacity. Following elements influence heat transfer capacity of a condenser:

Material

Because different or various materials possess variable heat transfer capacities, therefore a condenser with given ability can be changed by opting suitable material. Size of condenser would be reduced if material's heat transfer rate was higher.

Amount of Contact

The condenser power can be changed by adjusting amount or quantity of contact between the condenser surface and condensing medium. This can be performed by changing surface area of condenser as well as the pace at which the condensing medium flows over it. The amount or quantity of liquid refrigerant in the condenser influences how much vapour refrigerant interacts with the condensing media.

Temperature difference

Heat transfer potential or ability of a condenser is opted by using temperature differential between condensing medium and vapour refrigerant. Heat transfer rate as well as capacity both rise as the temperature difference widens.

CHAPTER 7

COOLSELECTOR 2

Coolselector 2 is an industrial purpose application developed by Danfoss (A Danish multinational company) used by many professionals to design HVAC and air conditioning systems. Coolselector 2 helps you optimize energy consumption and increase efficiency in any HVACR system. Run unbiased calculations based on a set of operating conditions — such as cooling capacity, refrigerant, evaporation, and condensation temperature — and then select the best components for your design.

We used the Coolselector 2 application to design some of the components using the available resources. We also verified our theoretical calculations obtained through standard formulas and derivations. In this way the resulting designed system will be expected to behave in a similar condition when fabricated and tested in a real environment. The overview of the interface of the application has been displayed in this book using numerous figures.

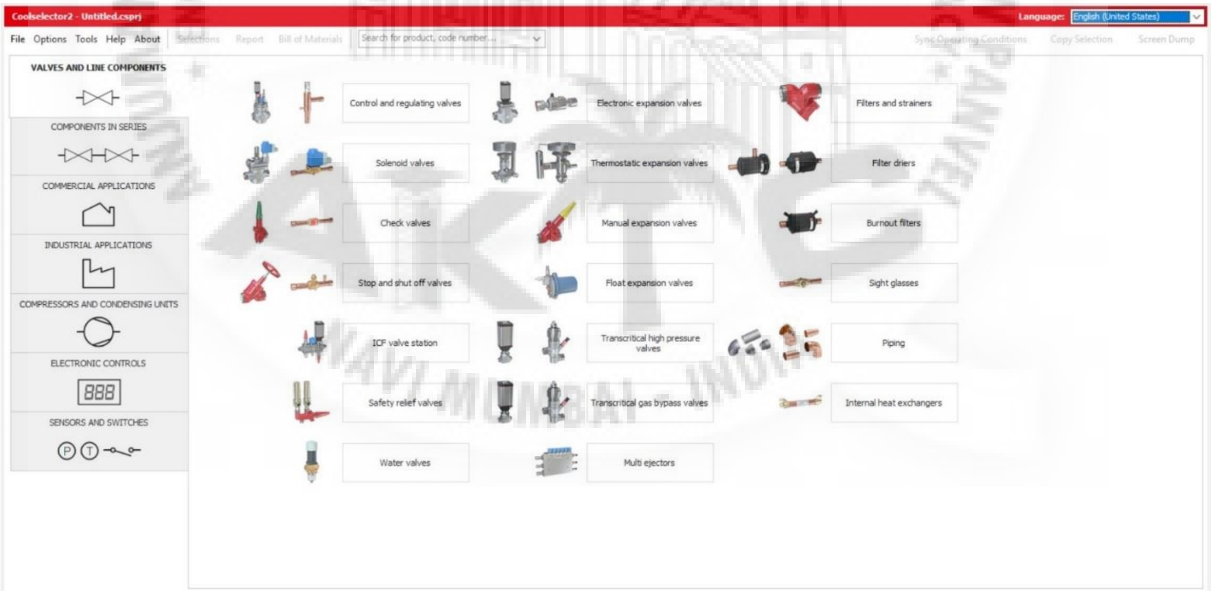


Fig 7.1: Illustration of the valves and line components used in the air conditioning system

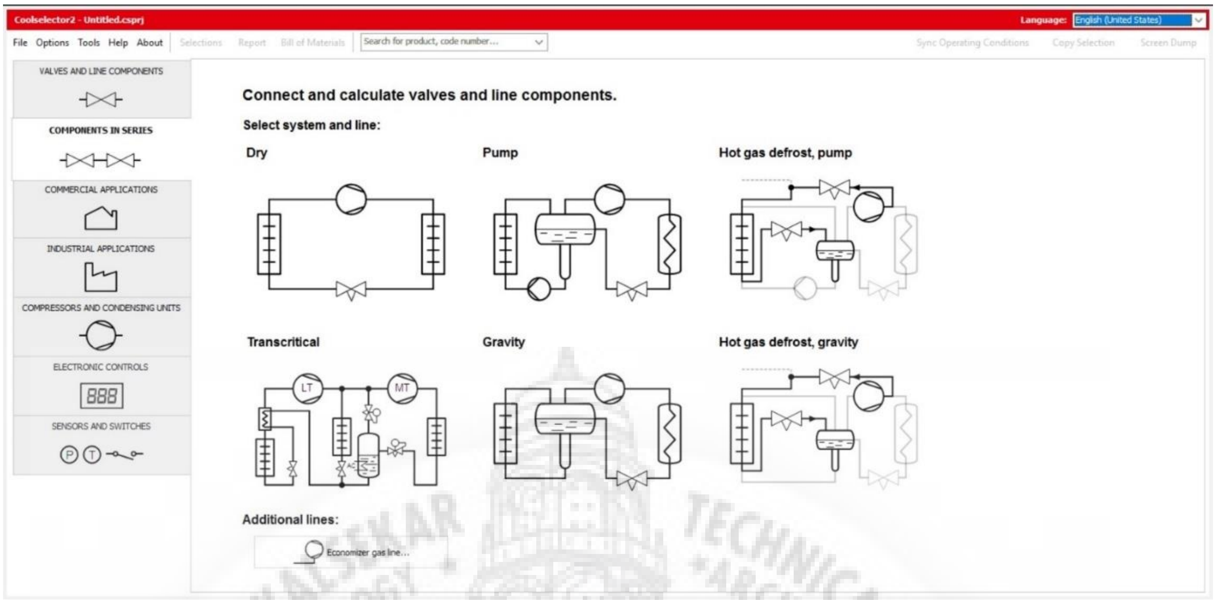


Fig 7.2: Illustration of the components attached in series

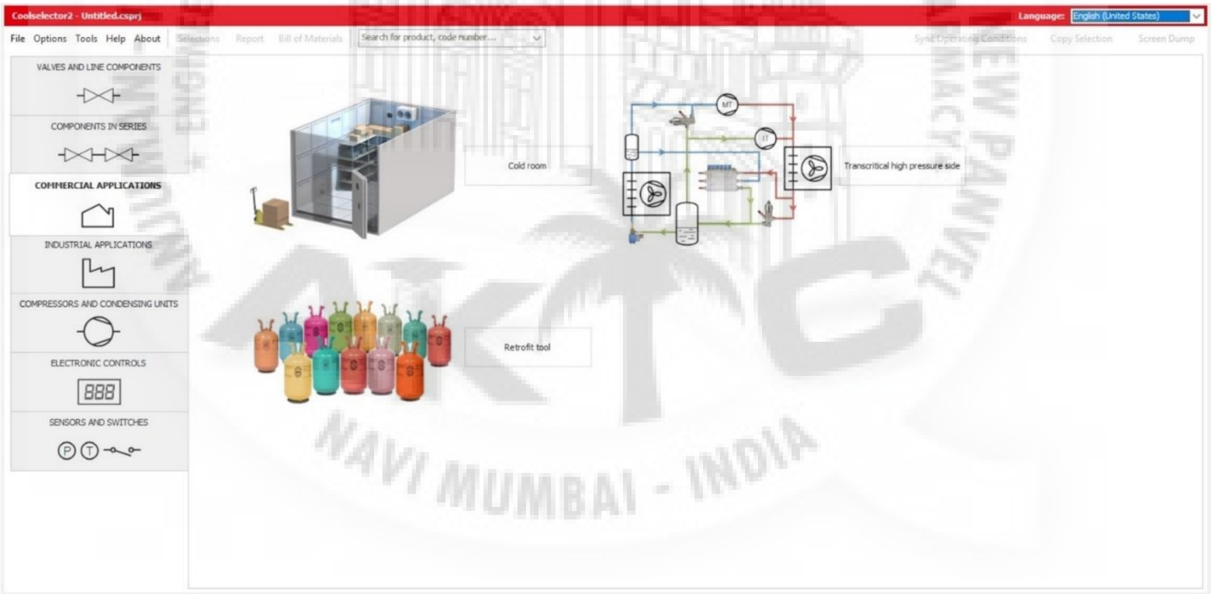


Fig 7.3: Illustration of the commercial applications

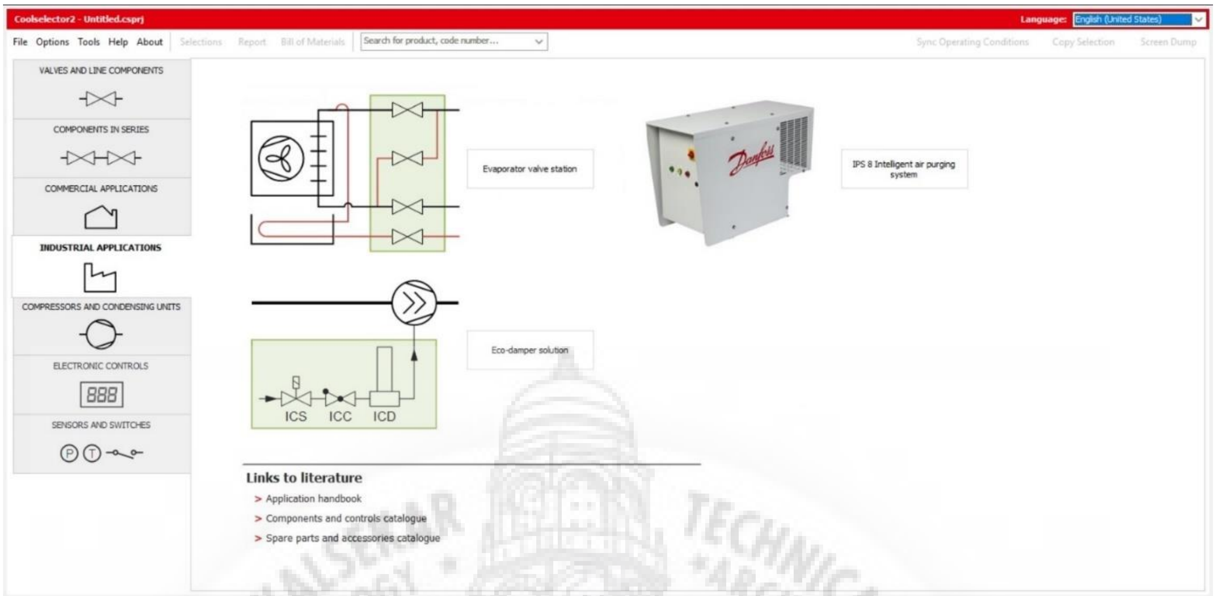


Fig 7.4: Illustration of the industrial applications

Fig 7.5: Illustration of the compressors and condensing units

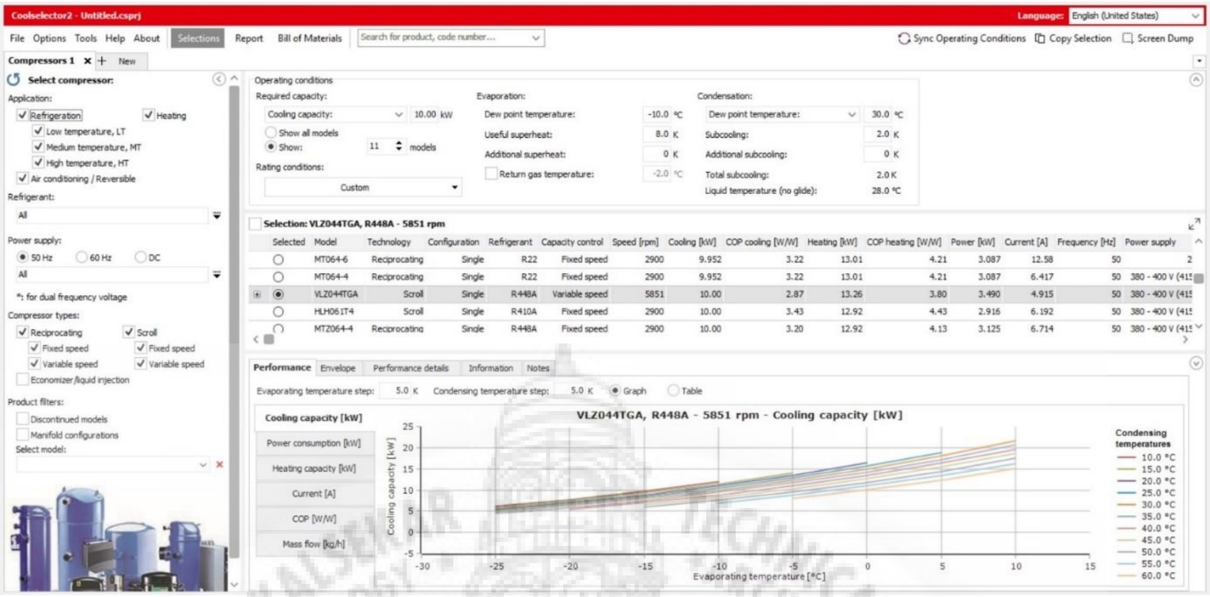


Fig 7.6: Illustration of the designing of compressor and selection of its properties

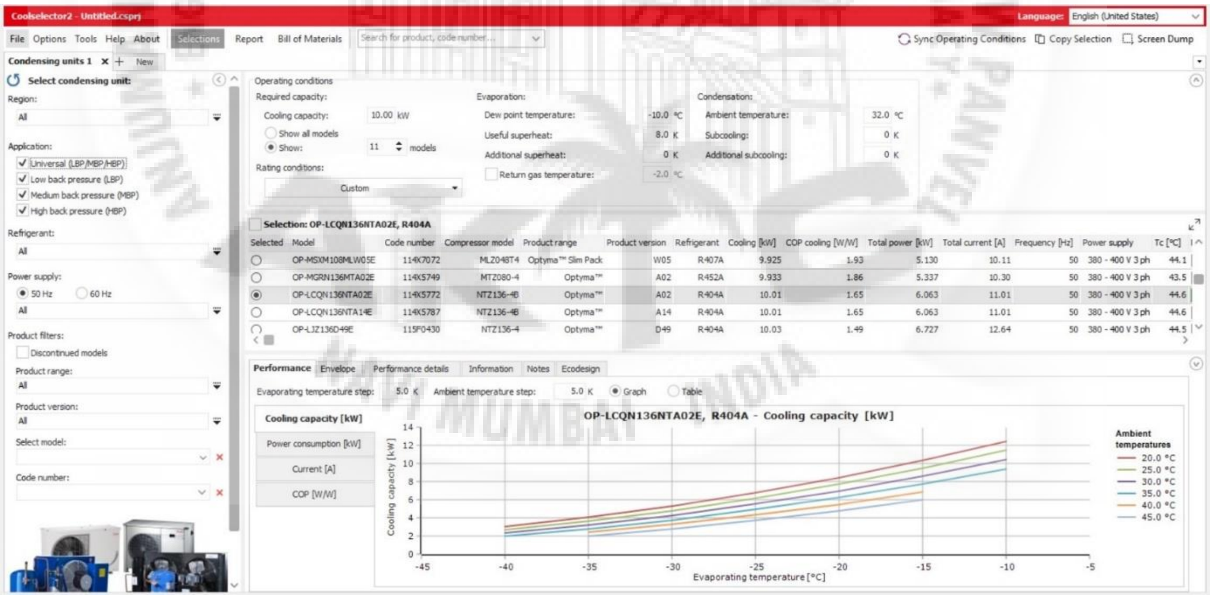


Fig 7.7: Illustration of the designing of condenser unit and selection of its properties

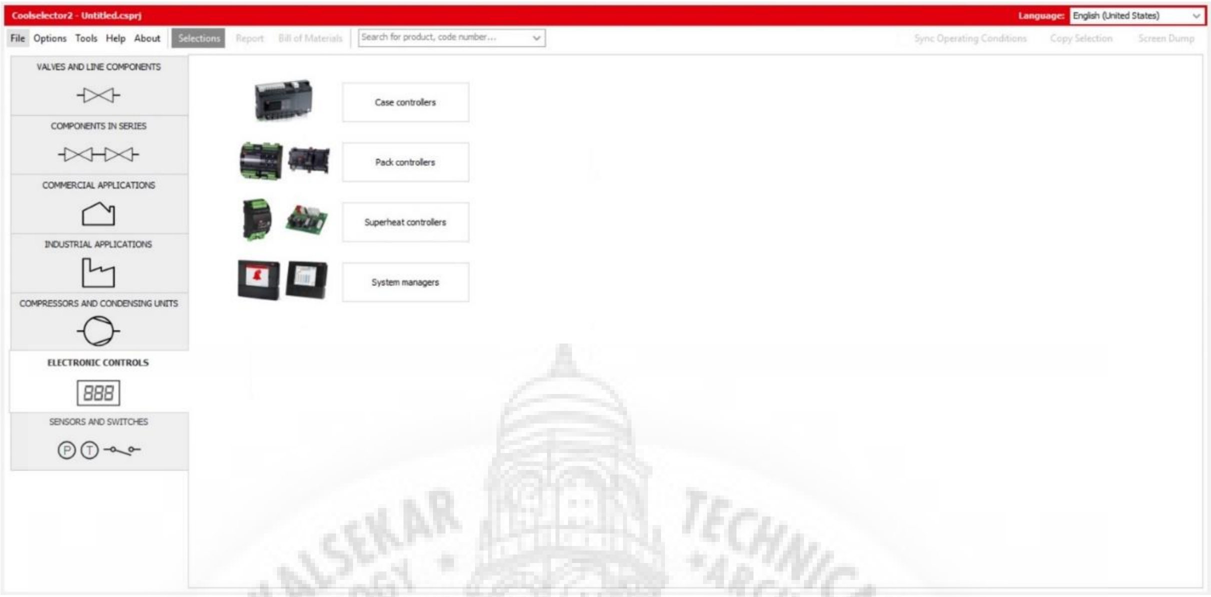


Fig 7.8: Illustration of the electronic controllers used in air conditioning systems

Fig 7.9: Illustration of the sensors and switches

CHAPTER 8

EVAPORATOR

8.1: Introduction

The evaporator's job is to collect a low-pressure, low-temperature liquid from the expansion valve and convey it to the load in close thermal contact. The refrigerant absorbs the carrier's latent heat and exits the evaporator as a dry gas. The refrigerant flow model and function of evaporators are used to classify them.

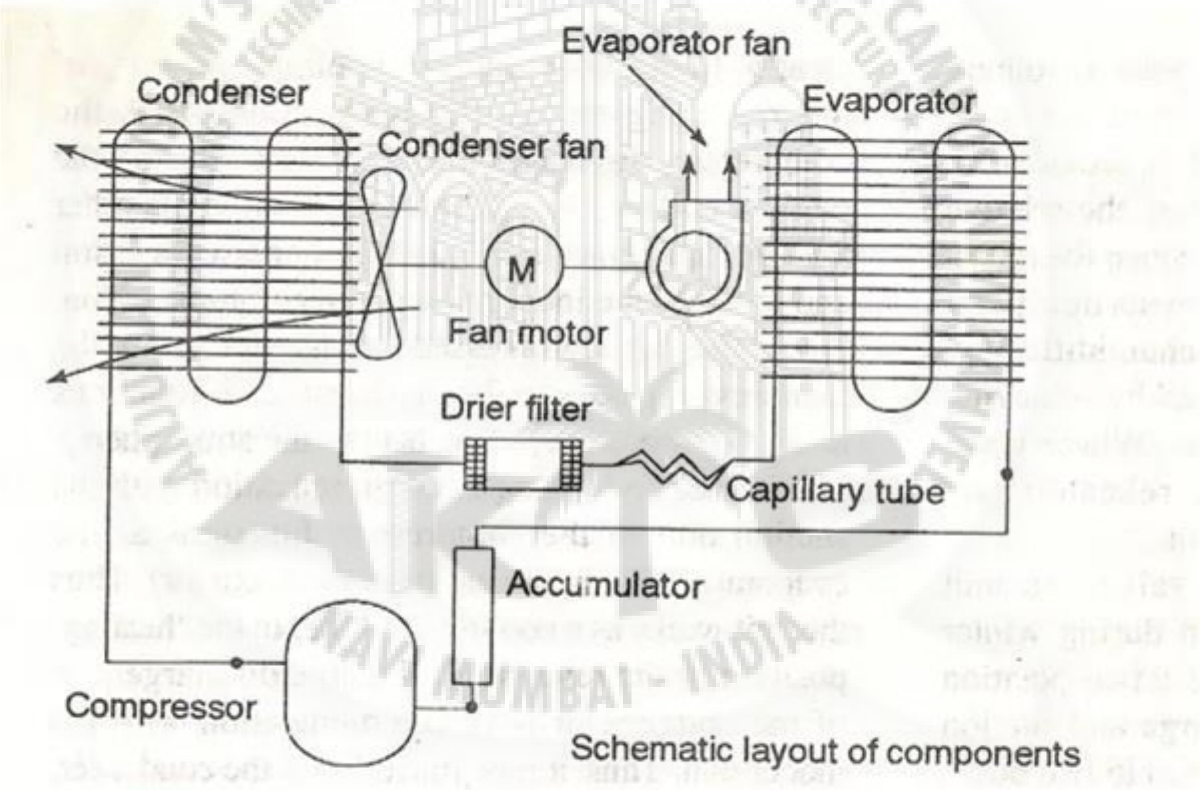


Fig 8.1: Illustration of the schematic layout of components

Flow patterns can be of two categories. Either the refrigerant flows uninterruptedly through the heat exchanger as it evaporates and becomes superheated, or it sits in a low-pressure vessel while it is evaporating or from where it is routed to individual coolers and back as a liquid/vapor mixture. By far the most shared type is the continuous flow category, called a direct expansion evaporator.

The purpose of the evaporator is to cool the liquid or air in most cases. The liquid or air will then cool the load. For instance, in a chilled display cabinet, the air is cooled and dispersed to preserve the contents at the required temperature; In water chiller systems, water is circulated to discrete fan coils to deliver air conditioning. In a heat pump, the function can be labeled as recovering heat from air or liquid, but the construction of the evaporator will be very comparable.

8.2: Classification of Evaporators

Air conditioning evaporators can be categorized into two types, namely:

- Air cooling Evaporators
- Liquid cooling Evaporators

8.2.1: Air cooling Evaporators

Air-cooled evaporators for performance cabinets, freezers cold rooms, and air conditioners have fins. Meanwhile all standards of extremely small chillers such as residential and miniature will have a fan to sweep air through the coil. The element of construction is identical to the wind-cooled condenser. Aluminum fins on copper tubing are almost prevalent for halogens, with stainless steel or aluminum tubing for ammonia. Frost or water accumulates on the exterior of the fins and must be diverted. To facilitate this, the fins are perpendicular, and the air circuits horizontally, with a drain tray fitted underneath.

The tube will be large enough that the speed of the boiling liquid inside will generate turbulence, which will aid heat transfer. Depending on the size of the spool, the pipe diameter will range from 9mm to 32mm. The fin spacing will be a compromise between compactness (and expense) and the likelihood for condensation or freezing to plug the spaces between the fins. Compact air conditioners will have a 2mm spacing, whereas low-temperature cold room coils will have a 12mm spacing. The direct expansion type is invariant in an air-cooled evaporator.

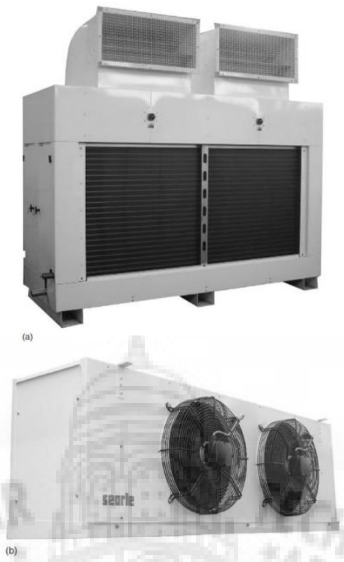


Fig 8.2: Floor mounted and ceiling mounted air-cooling evaporators

8.2.2: Liquid cooling Evaporators

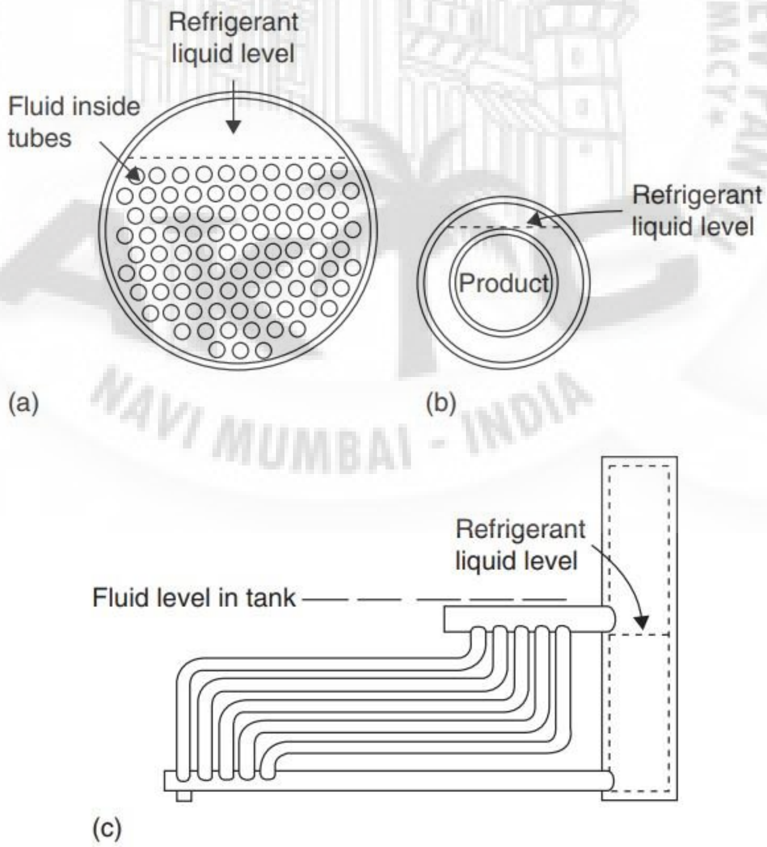


Fig 8.3: This figure illustrates the (a) Shell and Tube, (b) Jacketed, (c) Raceway

Liquid-cooling evaporators can be either uninterrupted expansion or submerged nature. Submerged evaporators possess an arbitrary boiling liquid body, with steam escaping from the top. In the event of ammonia, any oil present will sink to the base and be drawn out from the draining tank or oil draining attachment.

In a shell and tube model, the liquid is habitually found in tubes and shells filled with 3/4 boiling liquid refrigerant. Several tubes are eliminated at the peak of the hull to create an area for the suction gas to escape from the exterior without enclosing the liquid. Other characteristics such as repetitious outlet manifolds, suction trap vaults, and baffles will assist limit liquid droplets from accessing the main suction line. Gas velocities should not surpass 3 m/s and lower numbers are practiced by some designers. The momentum of the liquid in the tube should be around 1 m/s or higher, to promote internal disturbance for high-grade heat transfer.

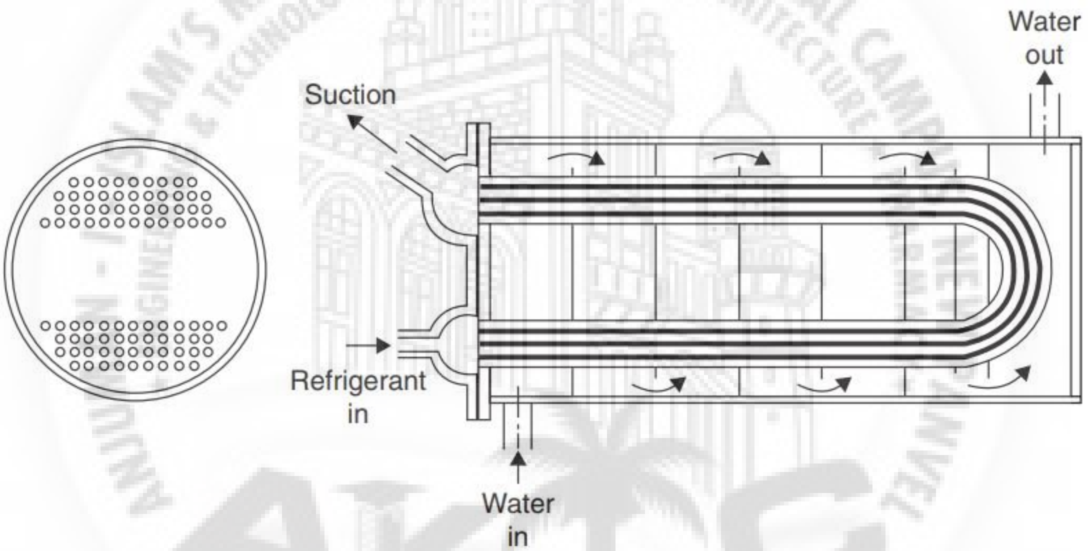


Fig 8.4: Shell and coil evaporator

The terminal cap baffles will restrict flow several times, as by shell and tube condensers. Liquid-cooling evaporators can consist of a tube coil in an uncovered tank and can have a linear expansion or flooded circuit. The flooded coils will be attached to a merged liquid accumulator and suction separator (commonly referred to as a booster drum), horizontally or vertically. The butterfly controls the liquid level in this drum and natural flow is established by bubbles leaving liquid refrigerant from the covering of the heat exchanger.

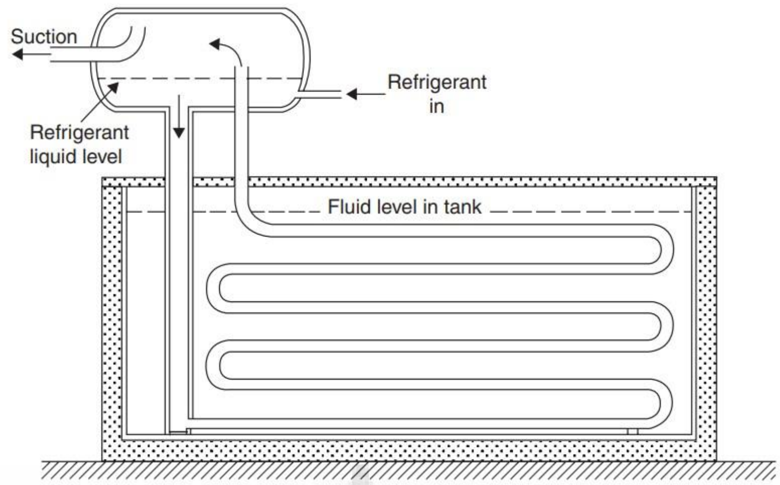


Fig 8.5: flooded tank evaporator

8.3: Defrosting

Air-cooled evaporators operating under 0 ° C will acquire frost and must be removed rhythmically as it will interfere with heat transfer.

The ambient air is continuously at a temperature of 4 ° C or more. It will suffice to hold the refrigerant for a while and permit the dew to thaw (as in a residential refrigerator that defrosts automatically). This arrangement can be used for cold rooms, packaged air conditioning systems, etc., where the drying time may be discontinued. In lower temperatures, heat should be utilized to melt the frost within a moderate time and guarantee it escapes. The techniques applied are as follows:

- Heating method based on resistance. The components are located within the coil or just beneath it.
- Vapors that are extremely hot. Superheated air is fed over the coil through a compressor outflow line. To generate hot air, the compressor must always use a different evaporator. Heat storage enclosures can be connected into the circuit to provide a modest installation with a limited amount of heat reserve.
- Cycle reverse. The regulation of refrigerant flow is inverted to cause the evaporator to serve as a condenser. Heat storage or other evaporator is needed as a heat source. In each of these events, provision should be made to eliminate refrigerant from the coil through defrosting. Drip pans and drain lines may demand additional heating.

8.4: The Concept of Multi Evaporators

Multi Evaporator, as the name implies, is a small evaporator meant to absorb the heat of a room and provide effective cooling to the user. The structure, refrigerant flow, components, air flow, and disposal of collected water from the unit may be different from standard evaporators.

This unit was created to improve the evaporator's performance and shorten the time it takes to cool a small space. The area required for the entire system's installation will be minimized, and maintenance will be simpler, according to this assembly.

Low power consumption is the significant advantage of this system. Using a single compressor and condenser, and with the refrigerant amount that can be increased and decreased utilizing storage tanks, and distributing the evaporators all the area, various areas or rooms can be cooled with only one system installed. The cooling of the individual room is independently chosen by the consumer and can be adjusted with the use of solenoid valves.

8.5: Vacuum-Isolated Delivery Pipes

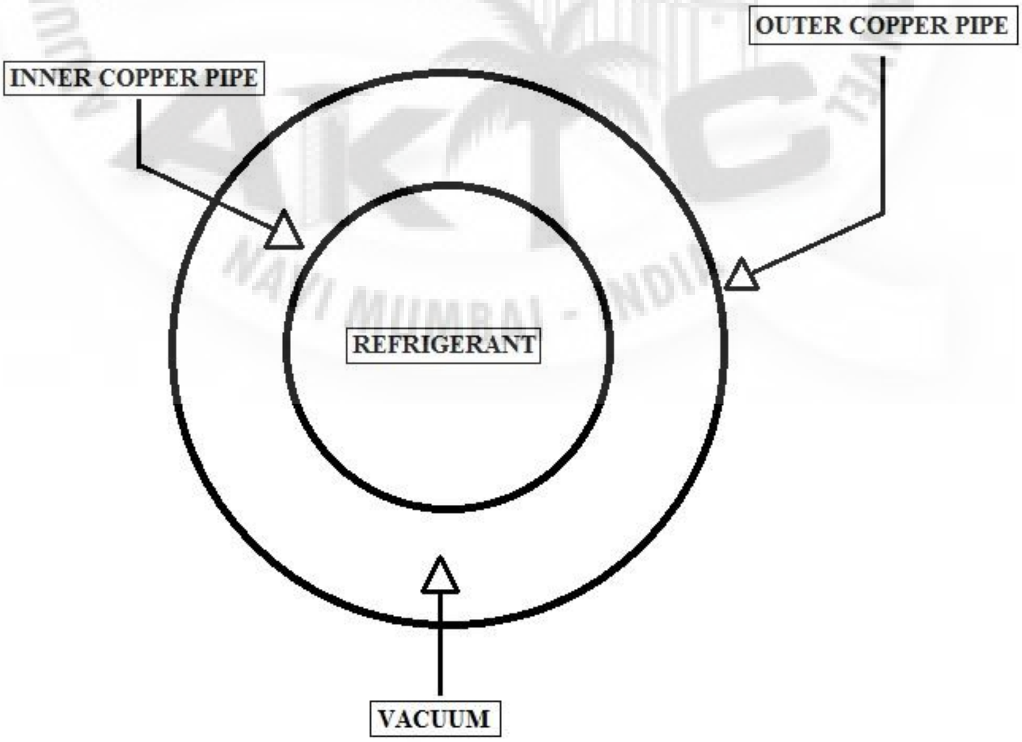


Fig 8.6: Sketch of vacuum isolated delivery pipes

- The gold-colored pipes are indicating the usage of vacuum-isolated delivery pipes.
- After processing through the throttling device, the refrigerant needs to be isolated from the surroundings to ensure minimum cooling effect leakage.
- Thus, to avoid leakage, inner refrigerant carrying copper pipe is enclosed with a large diameter copper pipe with an arrangement of vacuum between them. That will ensure to stop the interaction of refrigerant with the environment.
- By using this kind of delivery, processed refrigerant can be obtained at a larger distance.

CHAPTER 9

STORAGE TANK

9.1: Introduction

Receiver, which is also known as "storage tank," can be found on everywhere. It possesses self refrigeration units and extremely big or huge commercial as well as industry based process system.

Storage tank, which is a common component of many refrigeration systems. It's essentially a storage vessel for extra refrigerant that's not in use. A storage tank is required for refrigeration system that are subjected to fluctuating heat and loads that use a condenser flooding valve to maintain a pressure ambient temperatures.

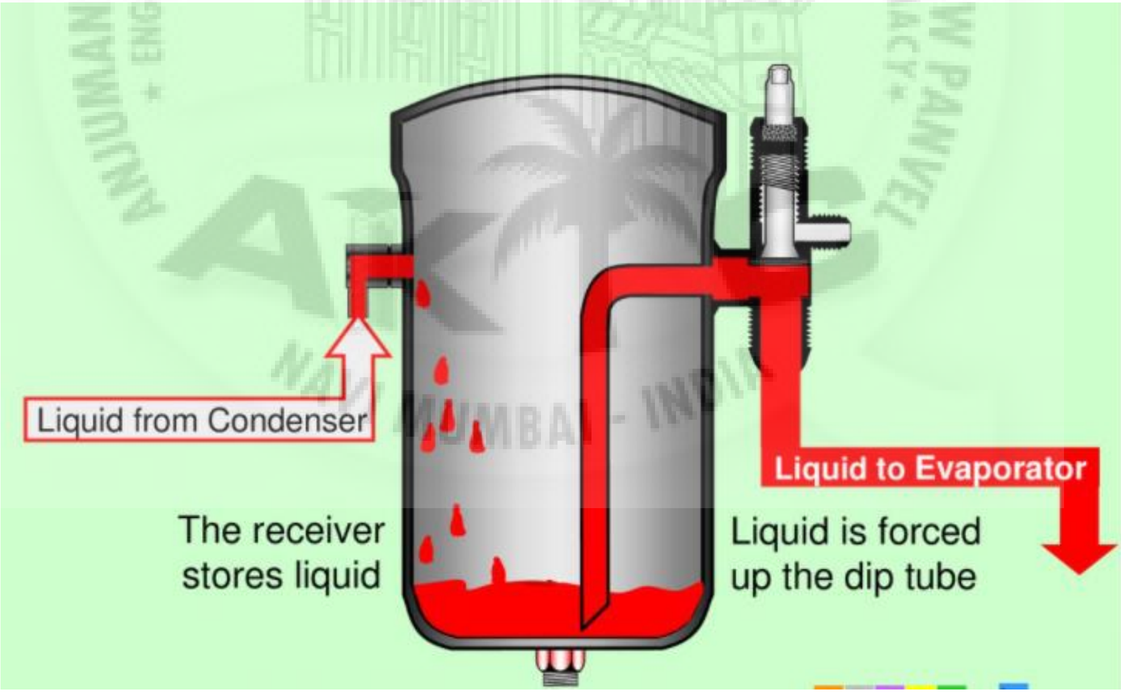


Fig 9.1: Storage tank or liquid receiver

9.2: Location

Liquid receivers or storage tanks, which are placed in liquid line or path as nearest to the condenser's exit as possible. In between condenser along with receiver, plumbing must be set up to allow for easy drainage. Pipe should also possess appropriately size valves and as well as connection fittings to avoid excessive or extreme friction pressure loss or gas binding.

Fig 9.2: Various forms of Storage tank or liquid receiver

9.3: Function

Many new technicians are confused by receivers and accumulators because they often used to work along with domestic air conditioning system. Storage tank (receiver) is located in liquid line or path succeeding condenser and as well as it colds liquid refrigerant, whereas accumulator can be situated in suction line or path before or prior to compressor liquid from compressor.

At the time, system is not working upto maximum heat load, liquid receiver accumulates refrigerant. It's usually constructed by keeping purpose as receiver can possess every of the system's charges while remaining under 80% filled. The design permits you to safely inject whole system charge into receiver without risk of hydrostatic pressure.

$$Storage\ Capacity\ =\ 80\%\ of\ Internal\ Volume\quad \ldots at\ 90°F\ Refrigerant\ Temp$$

CHAPTER 10

DESIGN

10.1: Design of Compressor

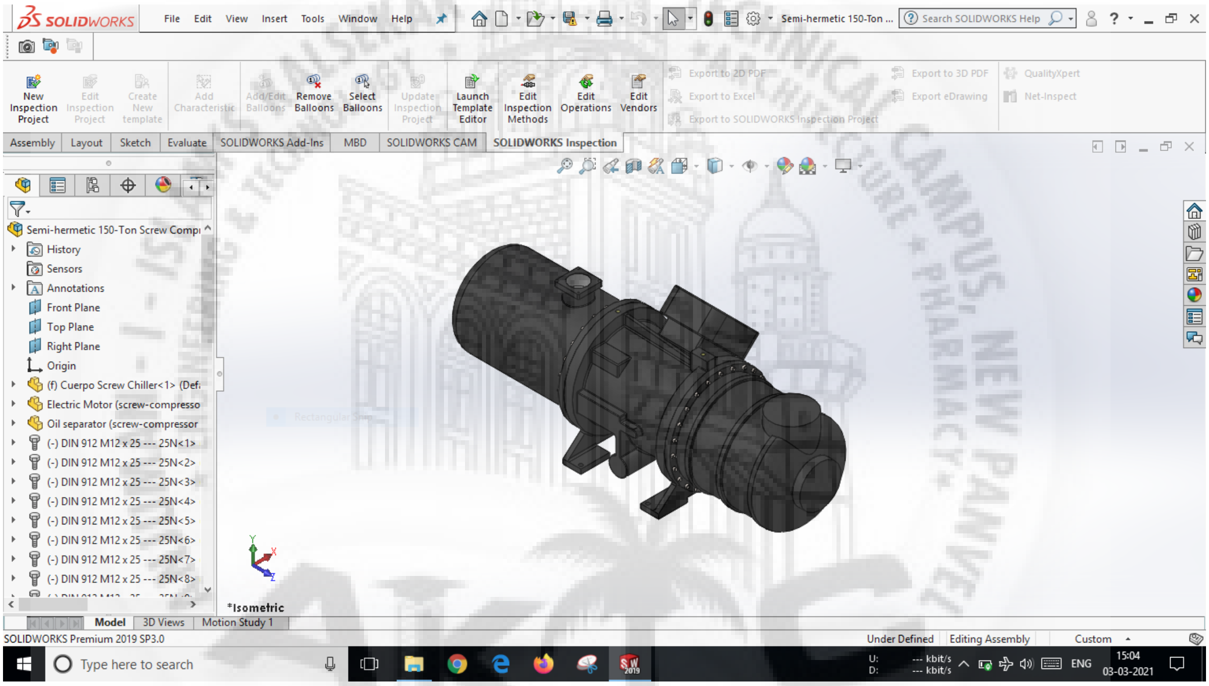


Fig 10.1: Design of screw compressor

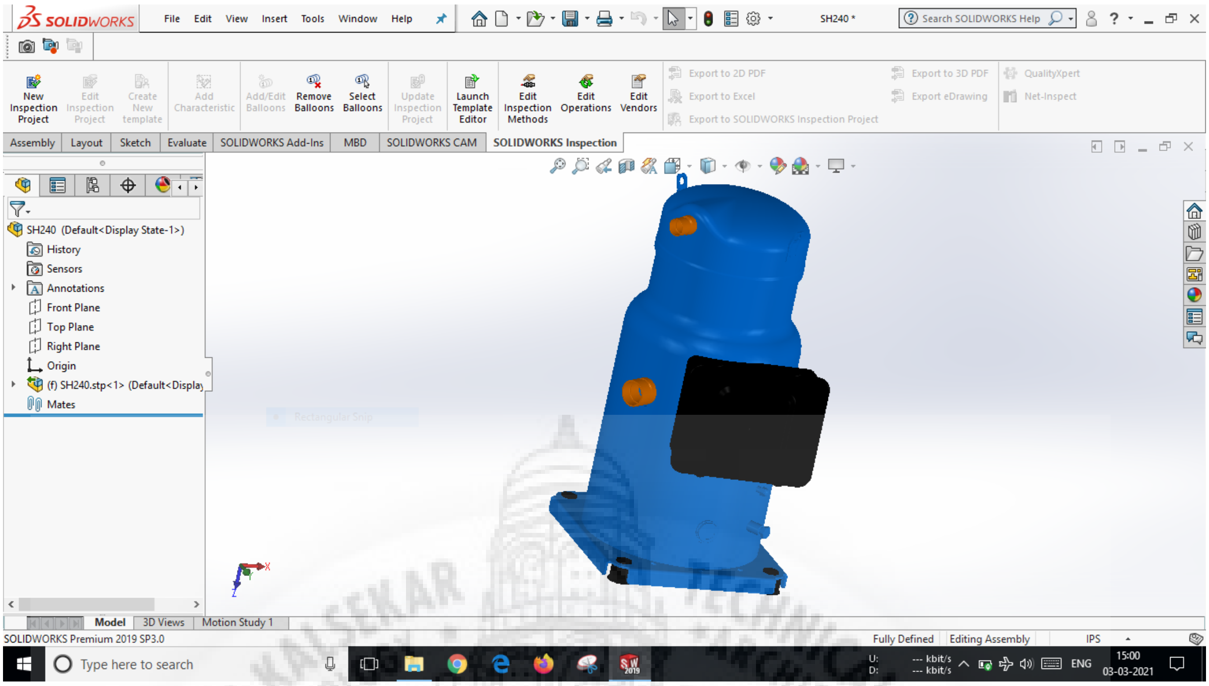


Fig 10.2: Design of scroll compressor

10.2: Design of Condenser

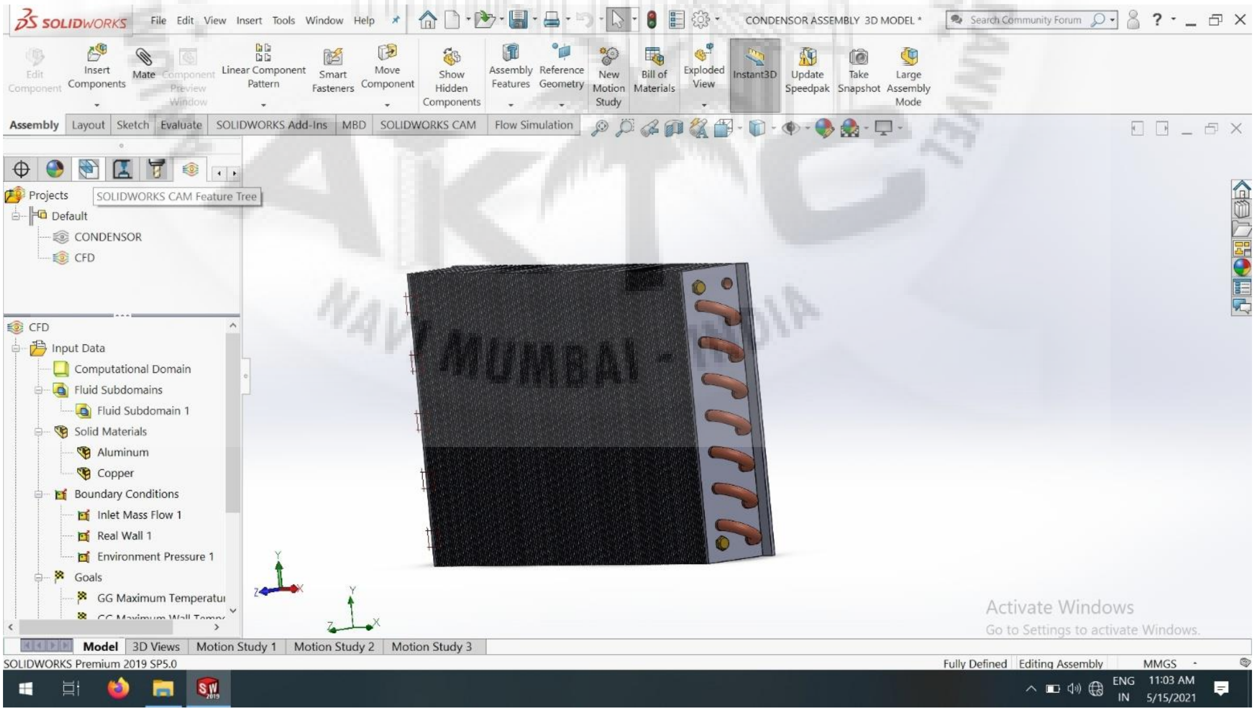


Fig 10.3: Design of condenser assembly

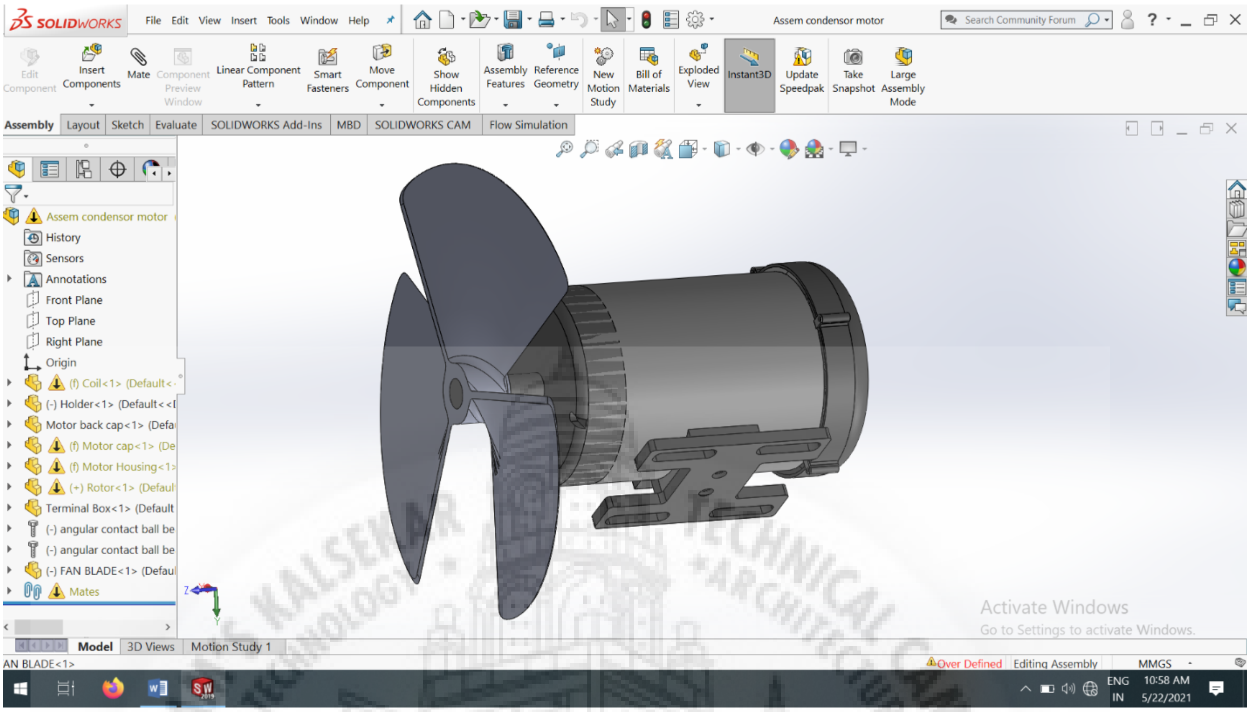


Fig 10.4: Design of motor assembly

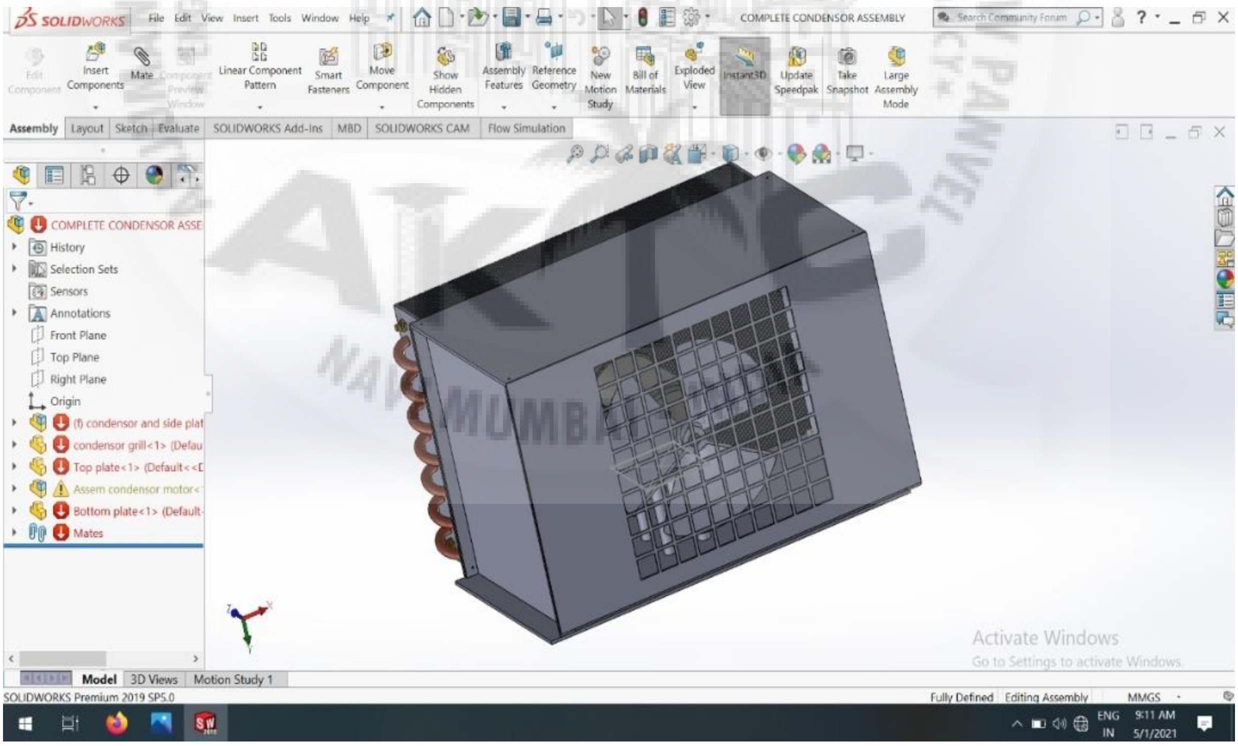


Fig 10.5: Design of complete Condenser Assembly

10.3: Design of Room

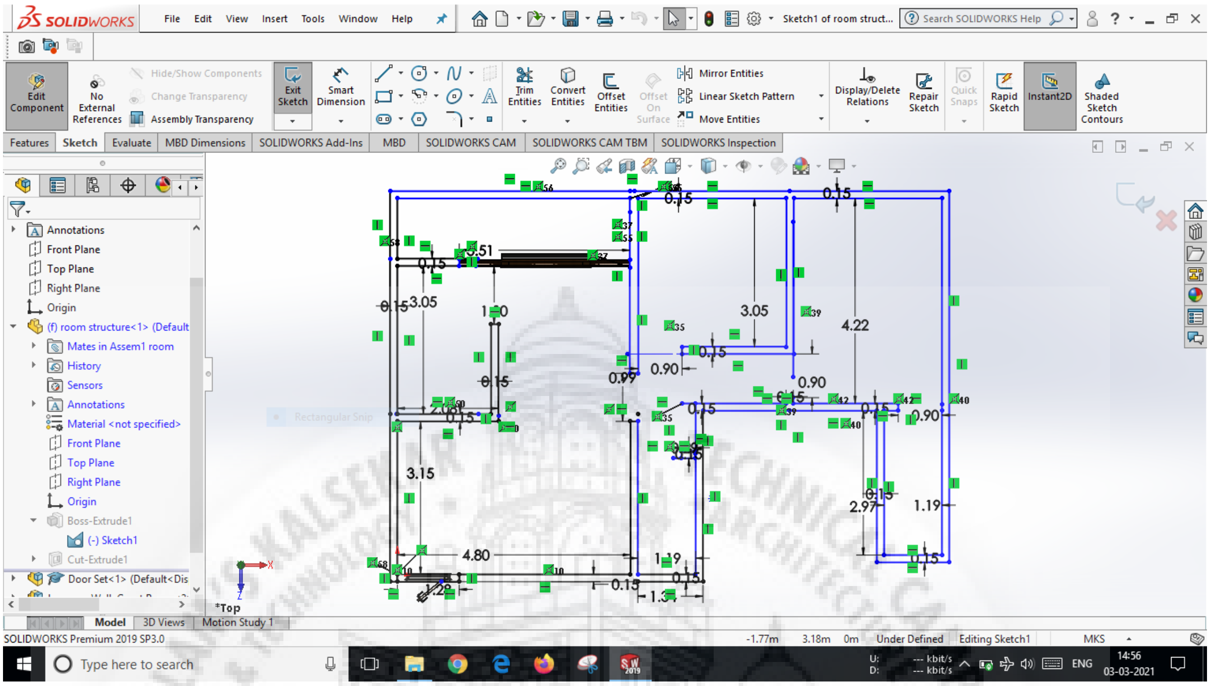


Fig 10.6: 2D sketch of room

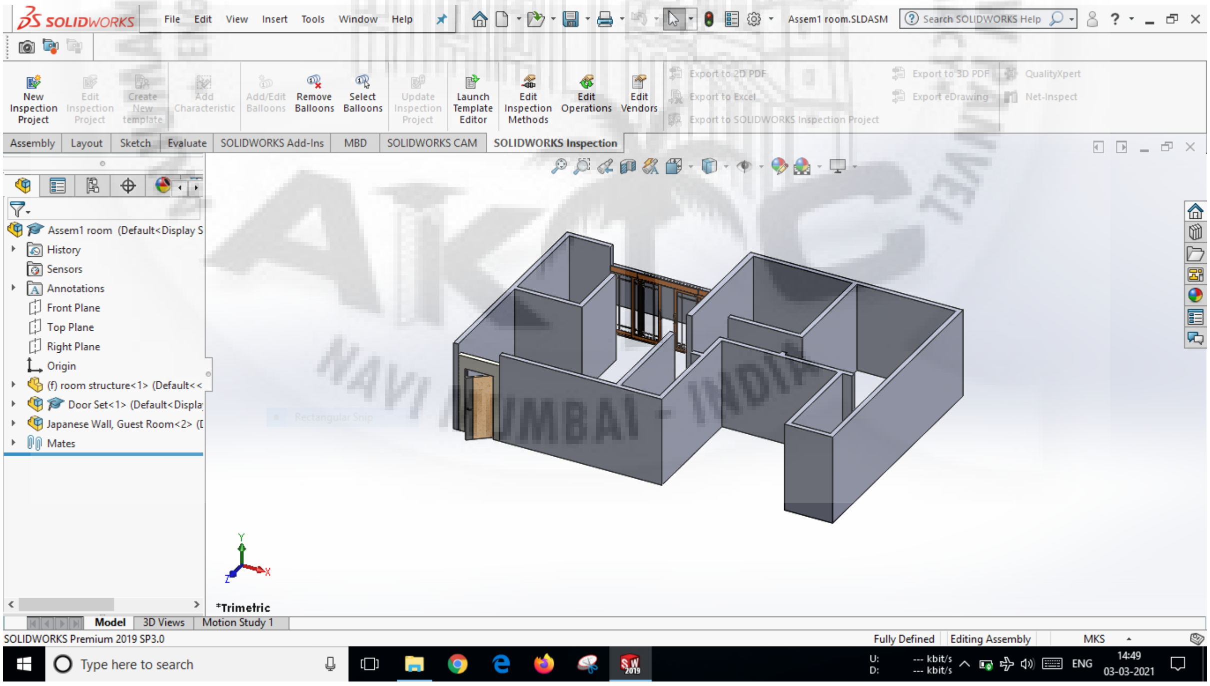


Fig 10.7: 3D design of room

10.4: Design of Evaporator

The 3-D model of the miniature evaporator is displayed below with labels indicating the title of the specific element.

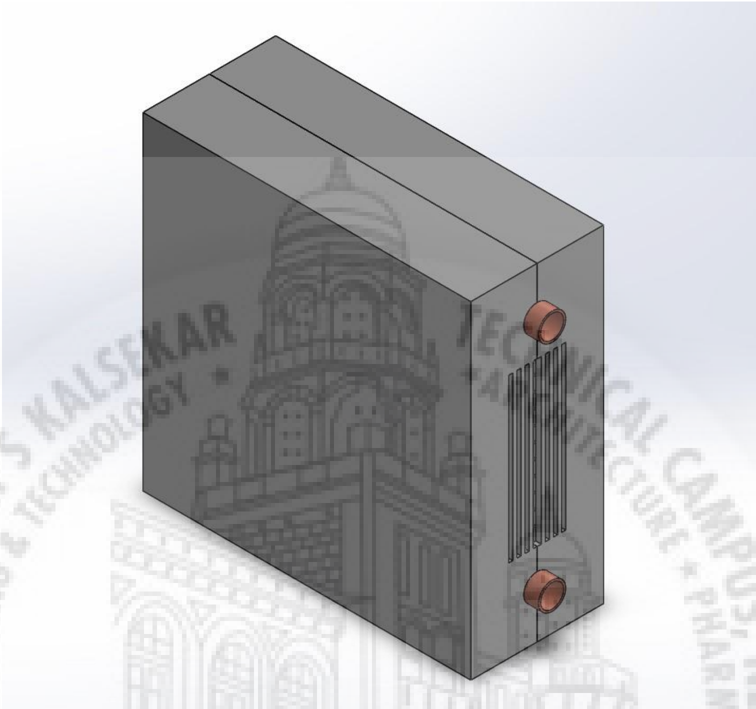


Fig 10.8: designed 3-D model of the evaporator (1)

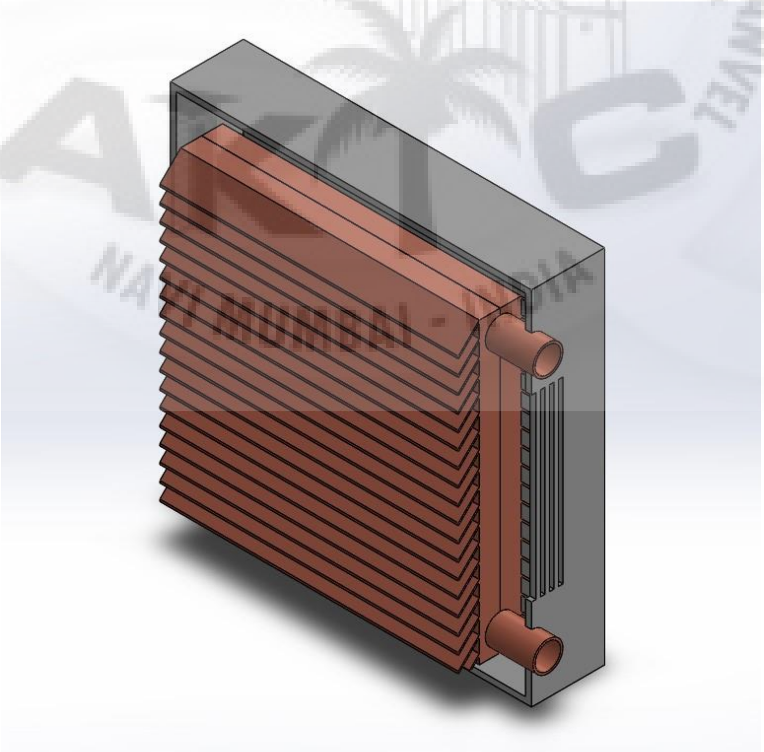


Fig 10.9: designed 3-D model of the evaporator (2)

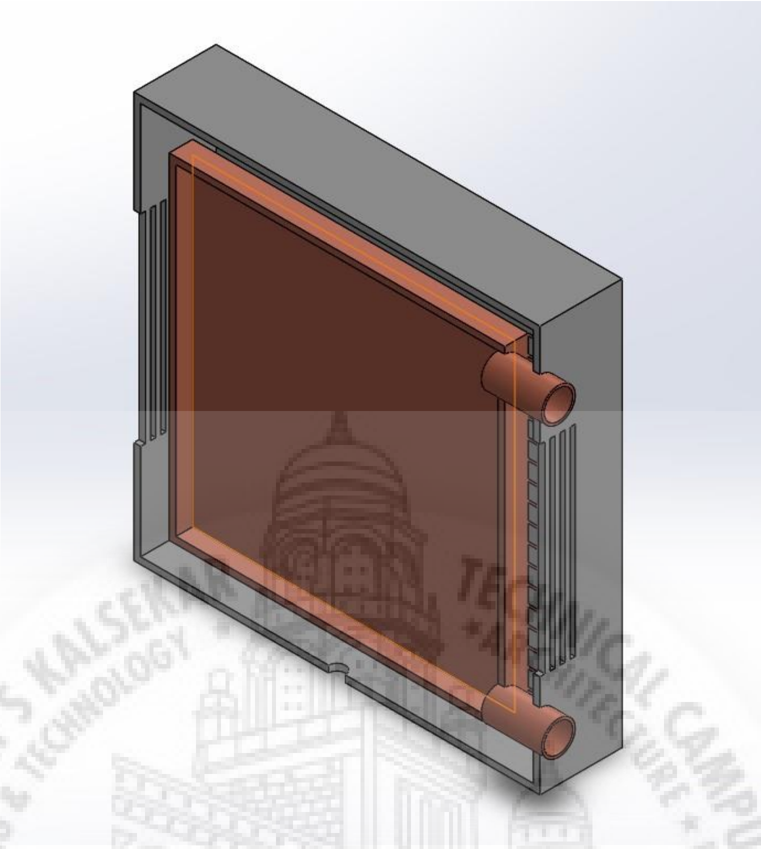


Fig 10.10: Section view of the 3D model of the evaporator

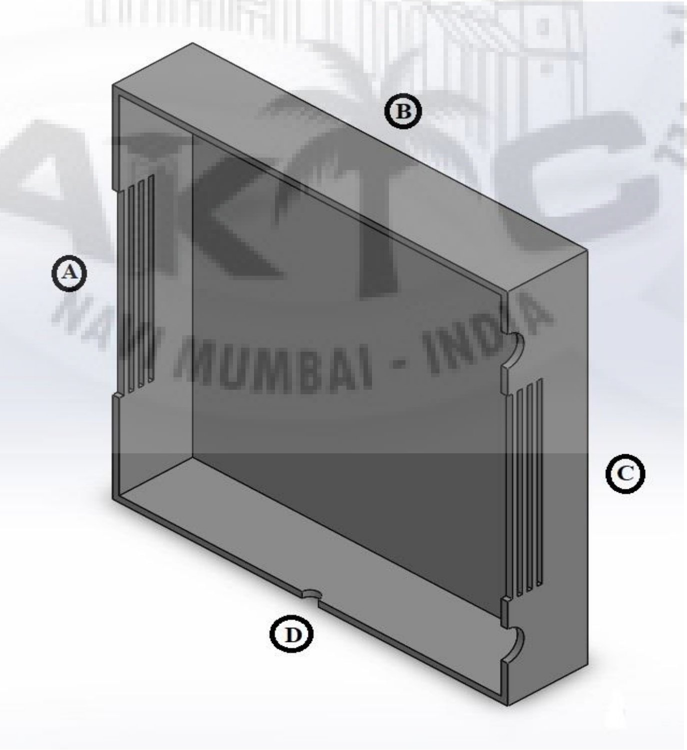


Fig 10.11: This figure illustrates the air passage casing

Figure 10.11 labeling:

A: Air inlet

B: Casing

C: Air outlet

D: Tube for the removal of water.

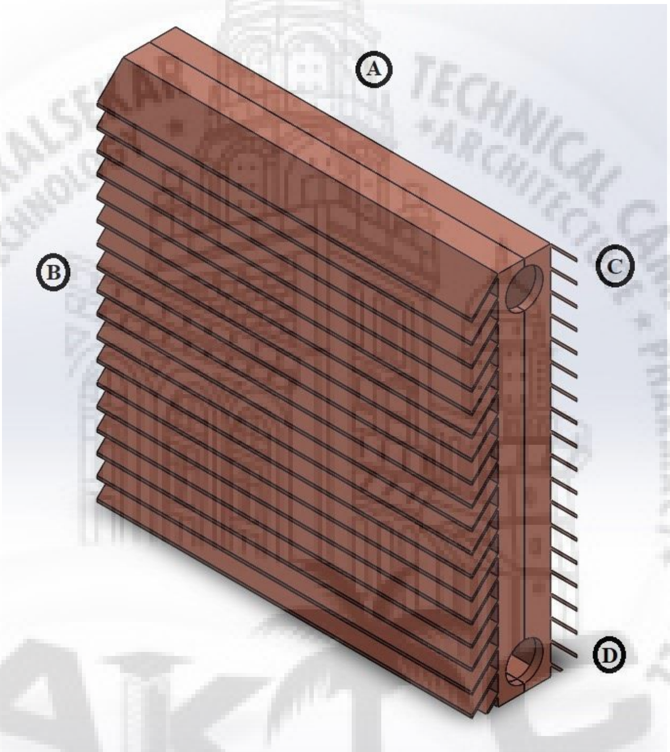


Fig 10.12: This figure illustrates the refrigerant plate

Figure 10 labeling:

A: Refrigerant Plate

B: Fins

C: Refrigerant Inlet

D: Refrigerant Outlet

CHAPTER 11

VALIDATION OF RESULTS

Multi-evaporator system is a system generally consisting of four major components:

1. Evaporator
2. Compressor
3. Condenser
4. Thermal expansion valve

Several loads may be mixed in a refrigerator at any same time. Refrigerators utilized to work at various loads and related to various temperatures and pressures. Multi evaporator setups which is based on one or several compressors may be conceivable.

To obtain various result related to this project, we will take thermal and stress analysis on different components. Then we will take those results in a tabular form which will help us to interpret these data to real environment conditions and results.

11.1: Analysis of Compressor

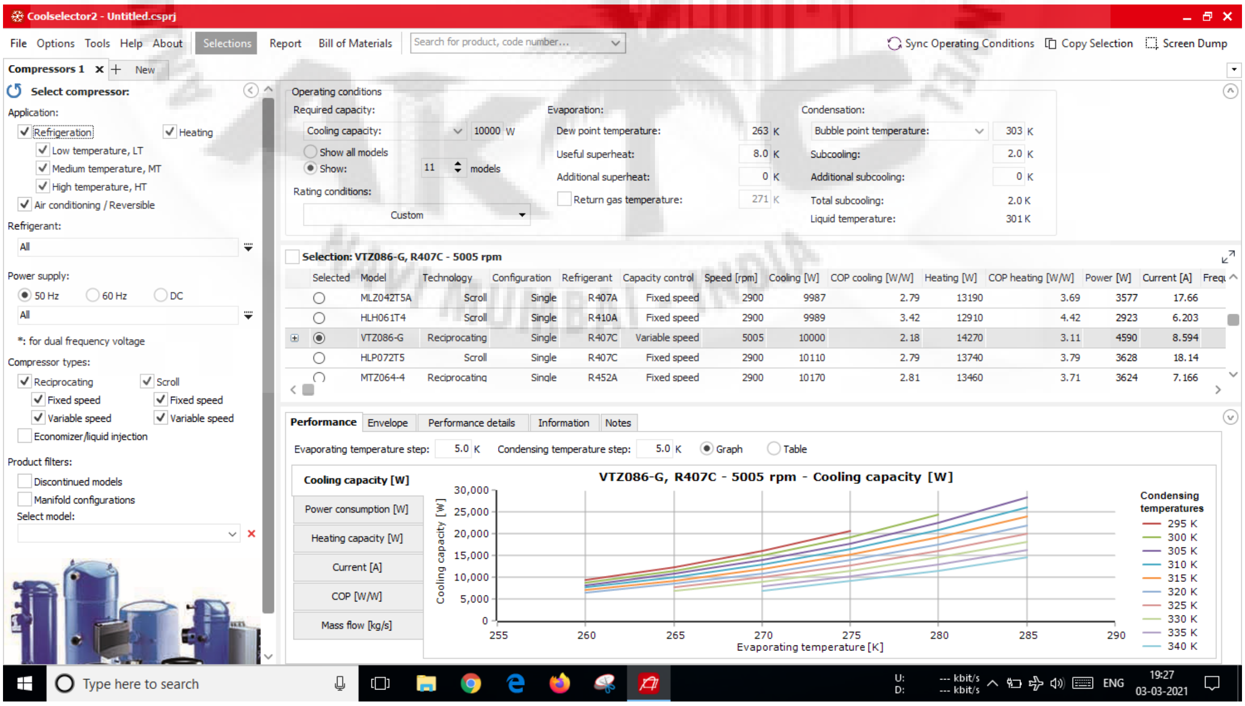


Fig 11.1: Performance of compressor

11.2: Analysis of Room

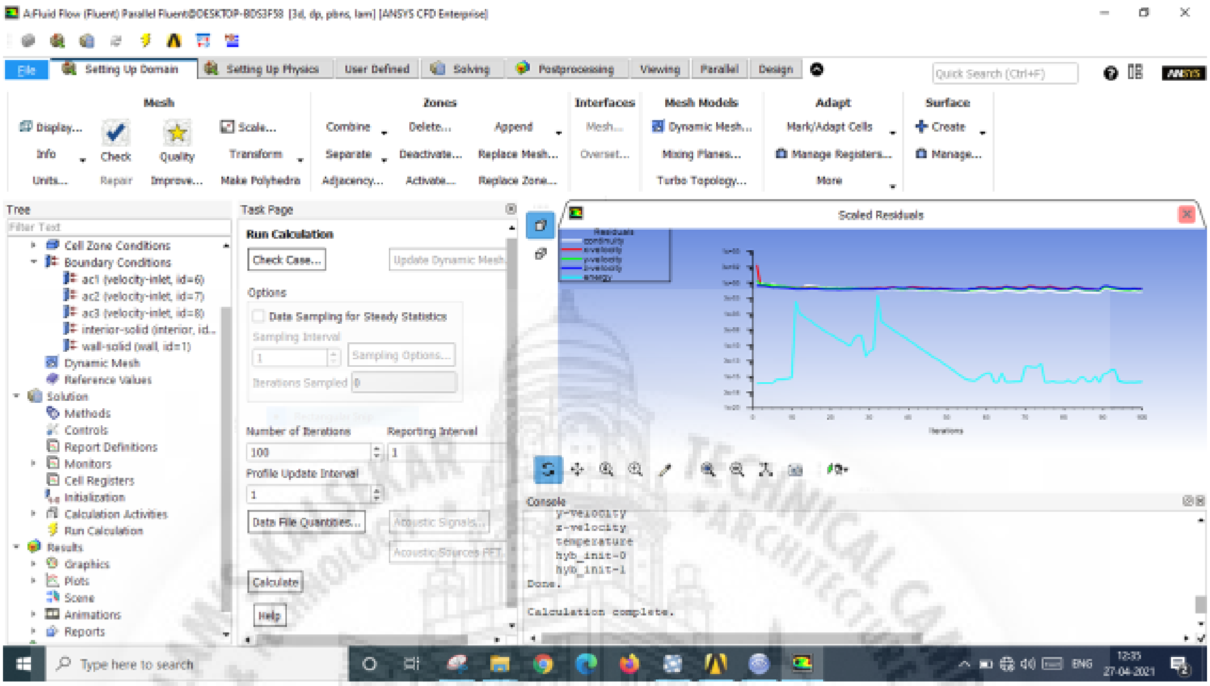


Fig 11.2: Characteristics of fluent flow of room

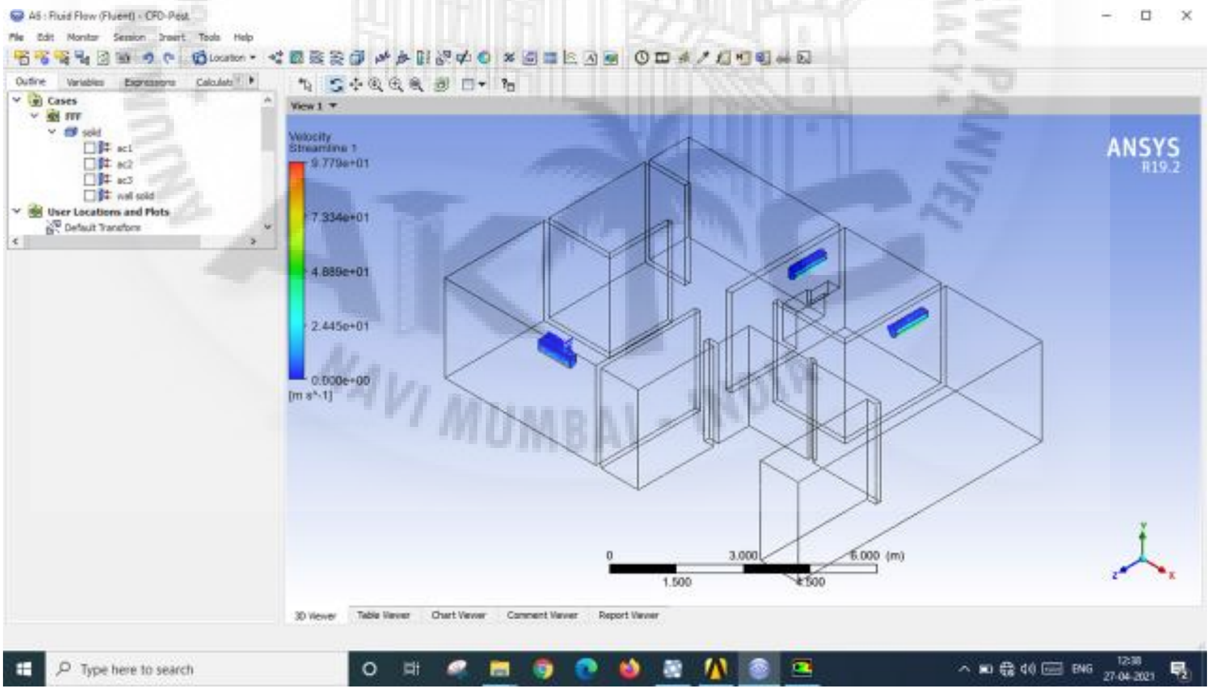


Fig 11.3: Fluent flow analysis of room

11.3: Analysis of Condenser

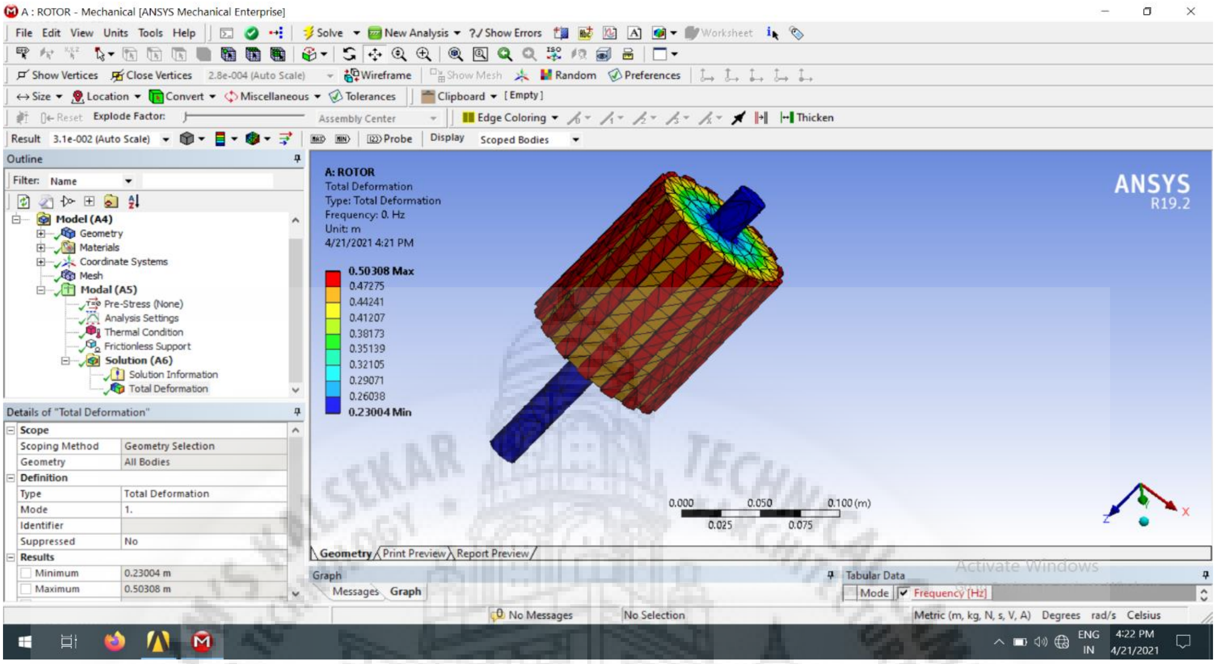


Fig 11.4: Total deformation of rotor

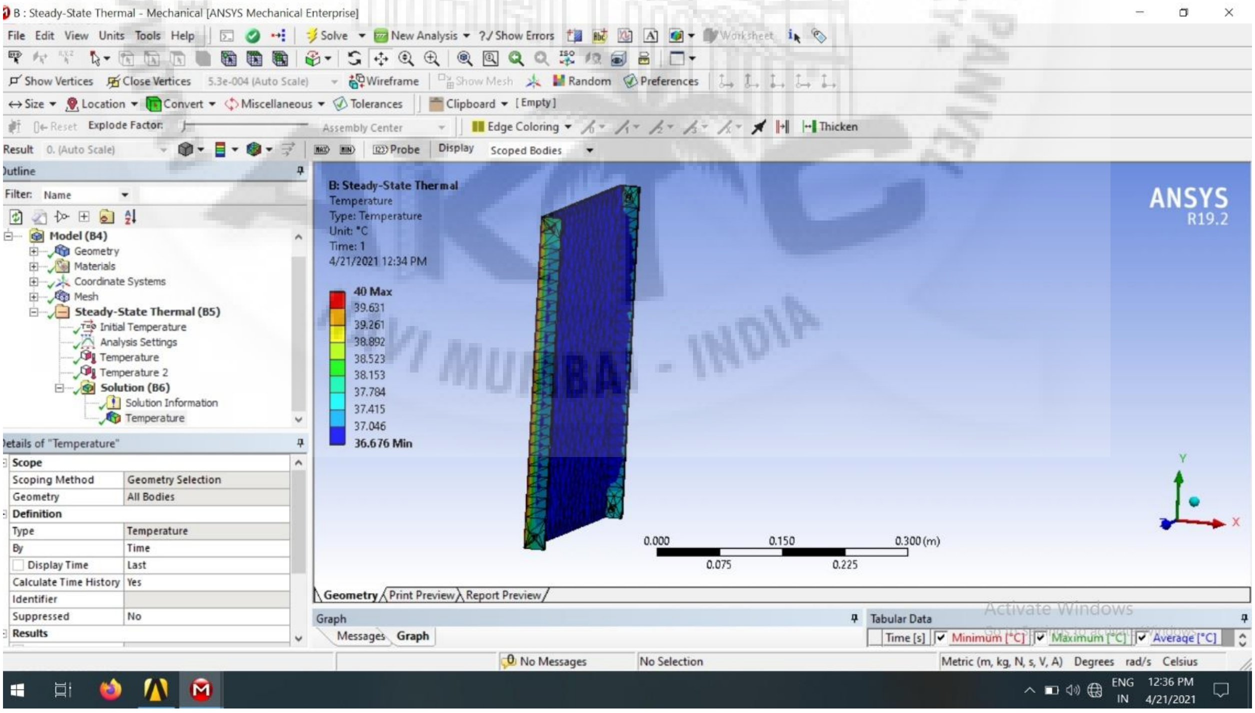


Fig 11.5: Temperature analysis on side plate of condenser

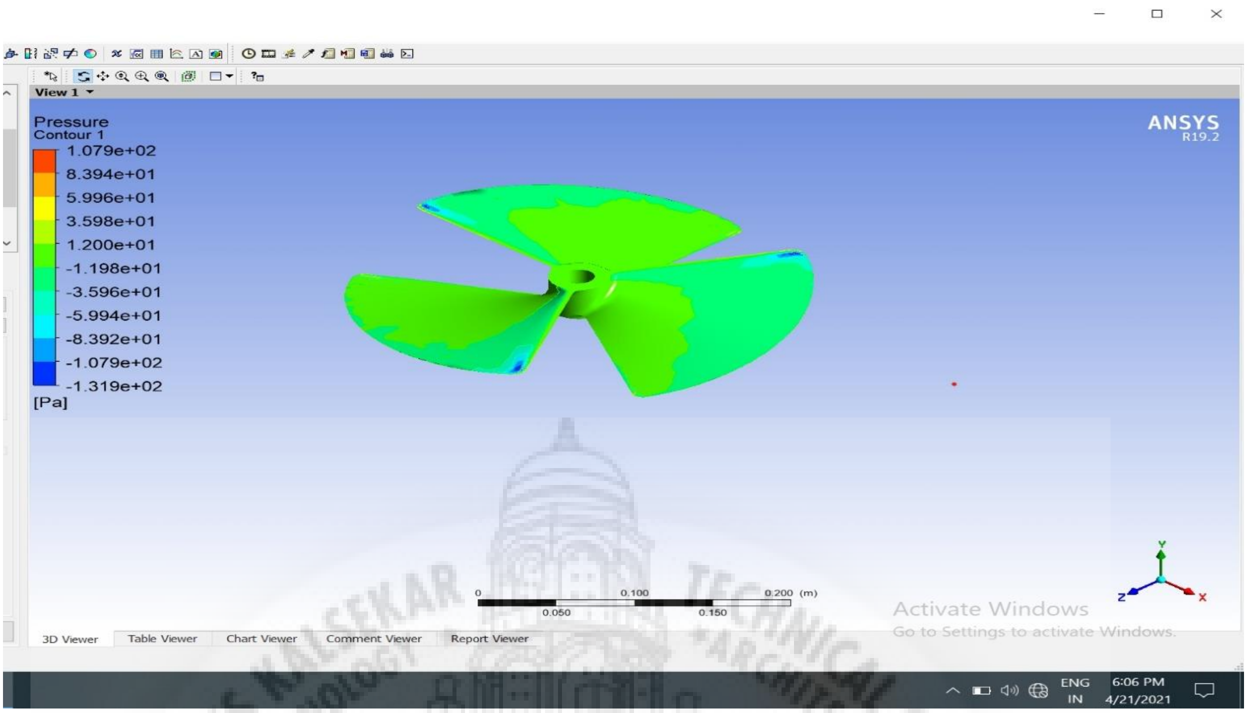


Fig 11.6: Pressure Analysis on Fan Blade

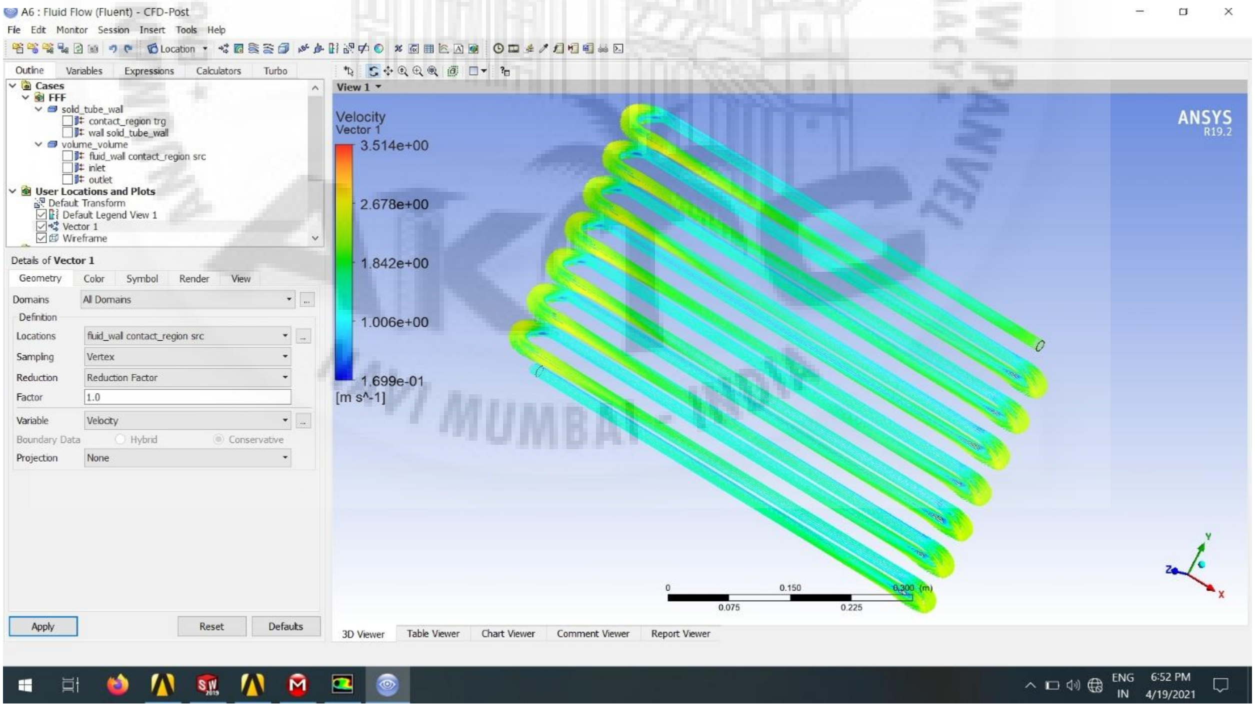


Fig 11.7: Fluid Flow in Condenser Tube

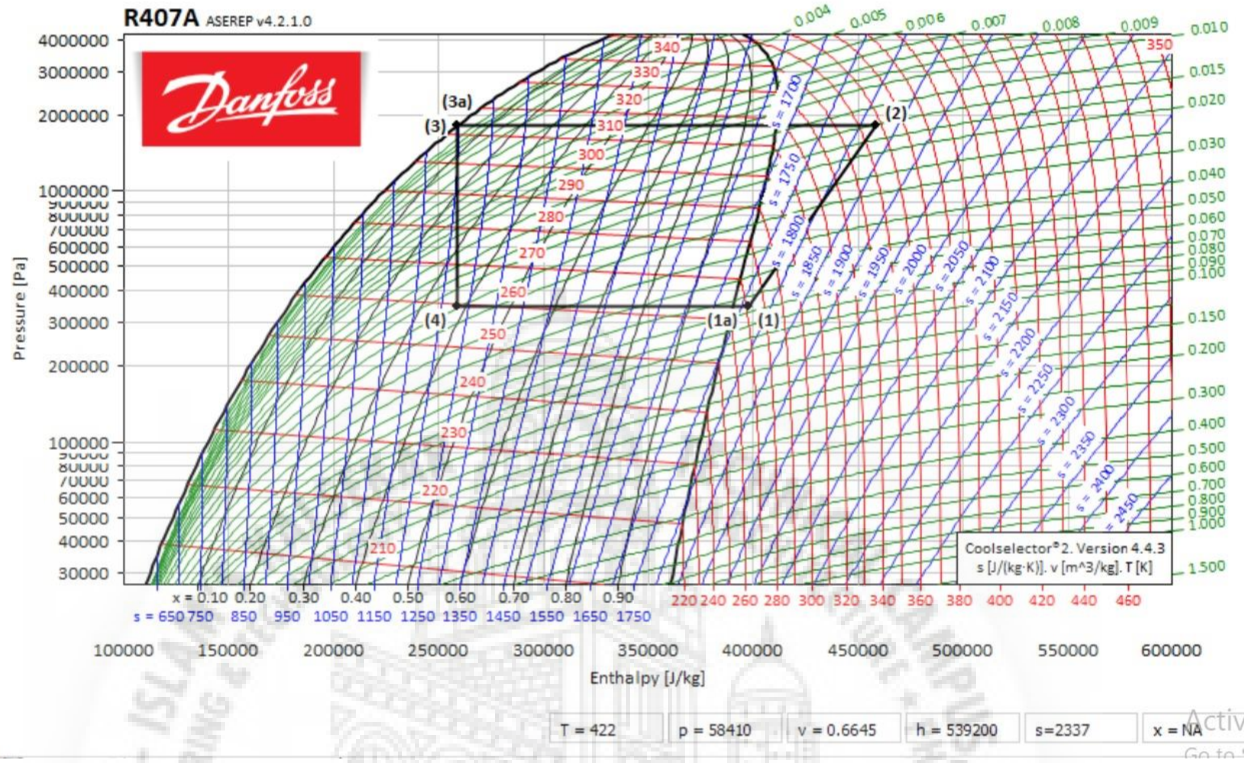


Fig 11.8: Pressure-Enthalpy chart diagram

Performance | Envelope | Performance details | Information | Notes | Ecodesign

Evaporating temperature step: 5.0 K Ambient temperature step: 5.0 K Graph Table

Cooling capacity [W] | Power consumption [W] | Current [A] | COP [W/W]

OP-MSXM108MLW05E, R407A - Cooling capacity [W]

Tamb\Te	250	255	260	265	270	275	280	285
290	-	-	-	-	-	-	-	-
295	-	8285	10270	12520	15060	17880	20990	-
300	-	7614	9497	11640	14050	16730	19700	-
305	-	6927	8705	10730	13010	15560	18380	-
310	-	6224	7889	9790	11940	14340	17010	-
315	-	-	7049	8817	10820	13070	-	-
320	-	-	-	-	-	-	-	-

Fig 11.9: Cooling capacity required in watt

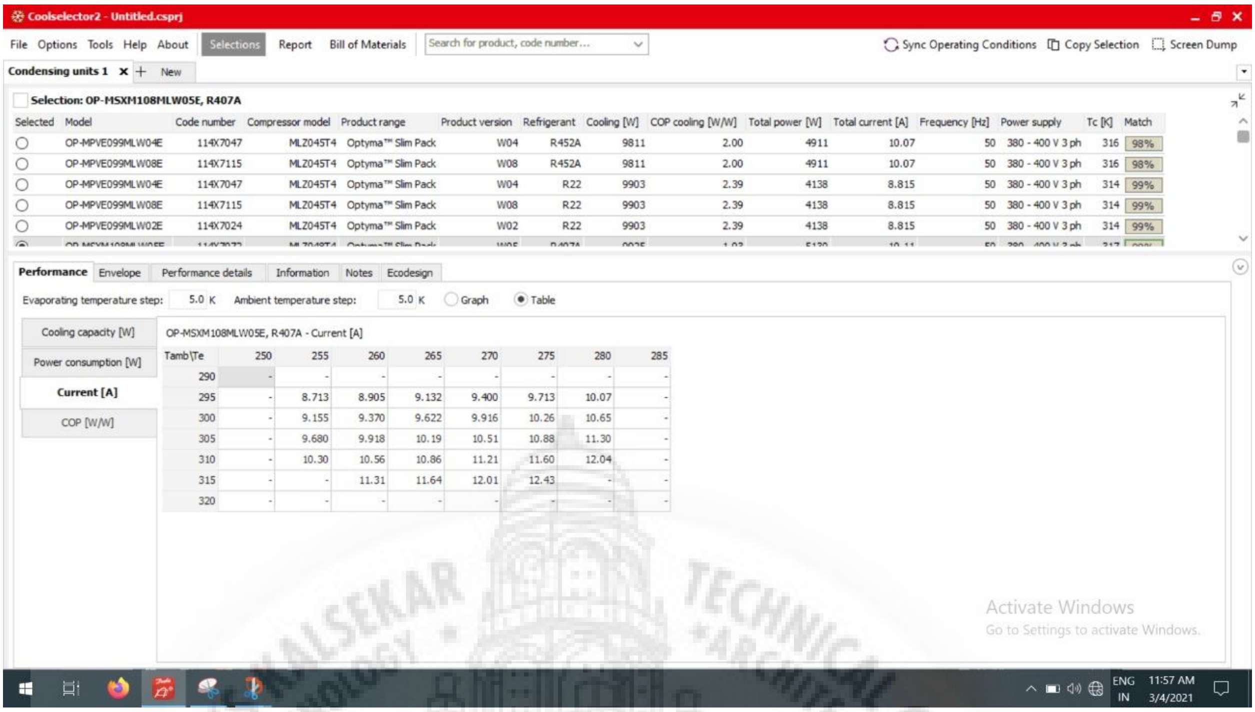


Fig 11.10: Current in ampere

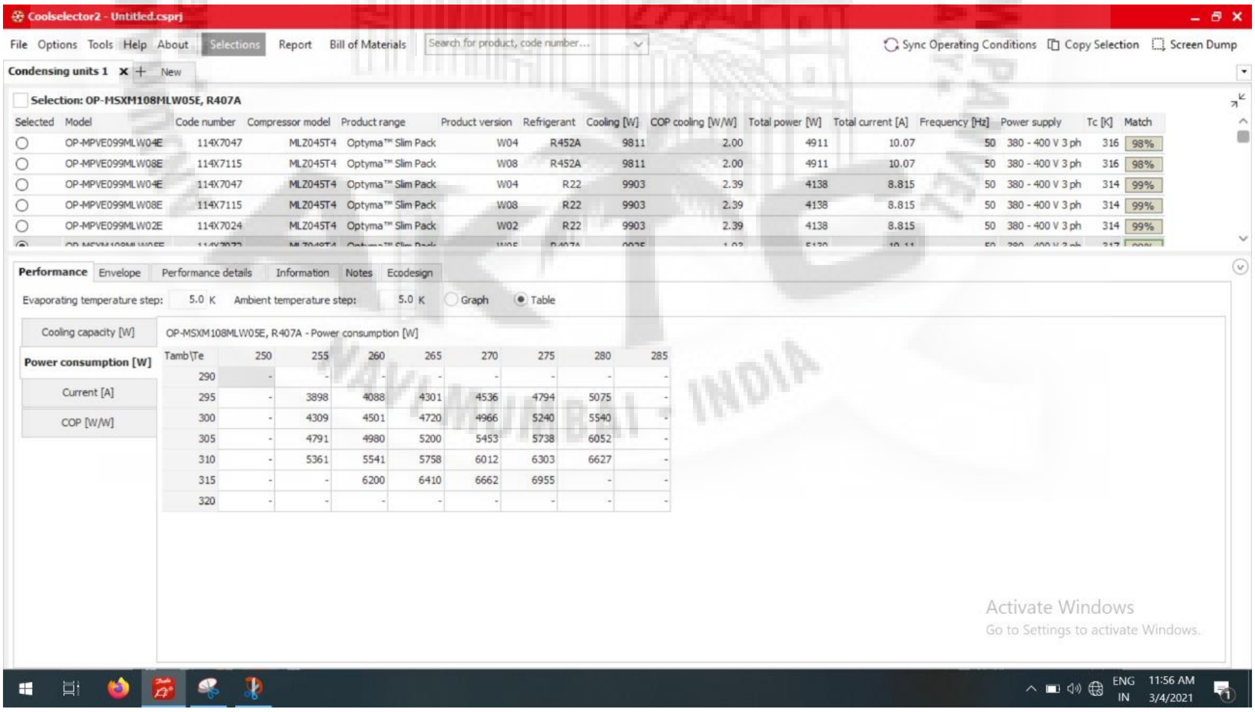


Fig 11.11: Power consumption in Watt

CHAPTER 12

OUTCOME

The air-conditioning system was subjected to various disturbances in order to investigate the ability of various types of air conditioning setup and expansion valve to maintain thermal comfort in the cabin. Although occupant comfort cannot be equated with a change in blown air temperature at the evaporator output, its evolution over time provides a solid indication of loop stability.

Following are the major areas related to outcome of this project:

- Only one compressor will be use.
- Only one condenser will be use.
- Multiple evaporators will be use.
- Various solenoid valves will be provided.

Thermal analysis by using ANSYS software will provide us more effective outcome that can be used to interrelate with other data also.

CHAPTER 13

FUTURE SCOPE

A standard refrigeration system has a single evaporator and operates at a single temperature. However, in many refrigeration installations, different temperatures must be maintained at various points throughout the facility, such as in hotels, large restaurants, institutions, industrial units, and food markets where food goods are delivered in huge numbers and stored at varying temperatures. Fresh fruit, fresh vegetables, cut meats, frozen products, dairy items, and bottled items, for example, are all stored at varied temperatures and humidity levels.

In such circumstances, each place is cooled by its own evaporator, allowing for better control of the environment. We need different temperatures for different applications in many industrial applications. For example, if we use a refrigerator and air conditioner in a commercial space, we can get a cooling effect for storing water bottles as well as a cooling effect for human comfort.

Because temperature requirements differ for different applications, it is difficult to achieve such a wide range of temperatures with a single refrigeration system. However, in order to maintain economy, low initial and operating costs, it is necessary to run a single refrigeration system with multiple evaporators. Simulation is also a valuable method for obtaining system outcomes under various operating situations.

CHAPTER 14

CONCLUSION

The existing project work can be continued, indicating that there is room for more effort. The following points can be evaluated with the same set-up for this purpose. The list is as follows:

- Different possible refrigerants can be used to analyses the system's performance.
- Different ambient temperatures can be used to evaluate the system's performance. Changes in the temperature of the local ambient air should be made artificially for this purpose.
- The system may be simulated using various software programs such as MATLAB, and the results can be compared to the experimental results.
- The effect of the refrigerant's heat transfer coefficient in the evaporator can be investigated.

CHAPTER 15

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