ABSTRACT

The main theme of project is hidden in his project name. The project named as Compact air conditioner. As per the name we were compact the size of existing window air conditioner as well as reduces the cost of AC and save power consumption as compared to existing 1 Ton air conditioner. We use some old component of car AC like compressor and condenser. We use double acting reciprocating compressor which is drive by B- grooved belt to 1hp electric motor and eco-friendly Refrigerant R-134a which is lowing cost and it does not affect the Ozone Layer depletion. So that the air conditioner supports the SAVE ENERGY and SAVE ENVIRONMENT.

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Nomenclature

COP	coefficient of performance
G	refrigerant mass flux (kg s^{-1} m^{-2})
GWP	global warming potential
h	enthalpy (kJ kg^{-1})
h_{fg}	latent heat (kJ kg^{-1})
k	thermal conductivity (W m^{-1} K^{-1})
$\dot{m}$	mass flow rale (kg s^{-1})
m_r	refrigerant mass flow rate (kg h^{-1})
P	pressure (kPa)
Q	total capacity (kW)
Q_l	latent capacity, portion of total capacity due water vapor removal (kW)
s^*	normalized entropy
T_{sat}	saturated temperature at the evaporator exit (°C)
$\dot{V}$	volumetric flow rate (m^3/s)
W	power (W)
x	vapor quality
μ	viscosity (μPa s)
p	density (kg m^{-3})
η	efficiency

CHAPTER 1: INTRODUCTION

- Air-conditioning like it says, 'conditions' the air. It not only cools it down, but also reduces the moisture content, or humidity. All air-conditioners work the same way whether they are installed in a building, or in a car.

- Turning on the air-conditioning actually reduces the number of miles per gallon of a car. There is energy used in removing the heat and moisture from the air in the car, and this consumes fuel because of the extra engine load.

As the name of project compact air conditioner same as their working. It means we reduced the size, cost & power consumption of air conditioner. We use car AC compressor (DENSO 10P08) that is very effective and double acting compressor. Another most important thing is condenser which rejects the latent heat of refrigerant and changes the phase of refrigerant from saturated vapour to saturated liquid and then refrigerant goes into dries filter which absorbs the remaining moisture content of refrigerant. A drastic pressure reducing stage comes in role it means expansion valve drops the pressure from 8 bar to 1 bar. At this stage actual cooling will occurs. Evaporator takes the latent heat of vaporization and changes the phase at constant pressure from saturated liquid to saturated vapour. After this stage, repetition of cycle will occur. Here we use R-134a as an refrigerant. It has better heat conductivity, non-explosiveand non-toxic therefore it is called eco-friendly refrigerant.

This project came in mind when we saw a small air conditioner in CNC machine. We also inspired by small size desert cooler which is portable, light weight and low cost.

1.1WORKING PRINCIPLE

An air-conditioning system works on the principle of simple vapour compression refrigeration system. It consists of following five essential parts:

1.1.1 Compressor:

The low pressure and temperature vapour refrigerant from evaporator is drawn into the compressor through the inlet or suction valve, where it is compressed to a high pressure and temperature. This high pressure and temperature vapour refrigerant is discharged into the condenser through the delivery valve or discharge valve.

1.1.2 Condenser:

The condenser or cooler consists of coils of pipe in which the high pressure and temperature vapour refrigerant is cooled and condensed. The refrigerant, while passing through the condenser, gives up its latent heat to the surrounding condensing medium which is normally air.

1.1.3. Receiver:

The condensed liquid refrigerant from the condenser is stored in a vessel known as receiver from where it is supplied to the evaporator through the expansion valve.

1.1.4 Expansion Valve:

It is also called throttle or refrigerant control valve. The function of the expansion valve is to allow the liquid refrigerant under high pressure and temperature to pass at a controlled rate after reducing its pressure and temperature. Some of the liquid refrigerant evaporates as it passes through the expansion valve, but the greater portion is vaporised in the evaporator at the low pressure and temperature.

1.1.5 Evaporator:

An evaporator consists of coils of pipe in which the liquid-vapour refrigerant at low pressure and temperature is evaporated and changed into vapour refrigerant at low pressure and temperature. In evaporating, the liquid vapour refrigerant absorbs its latent heat of vaporization from the medium (air, water, brine) which is to be cooled.

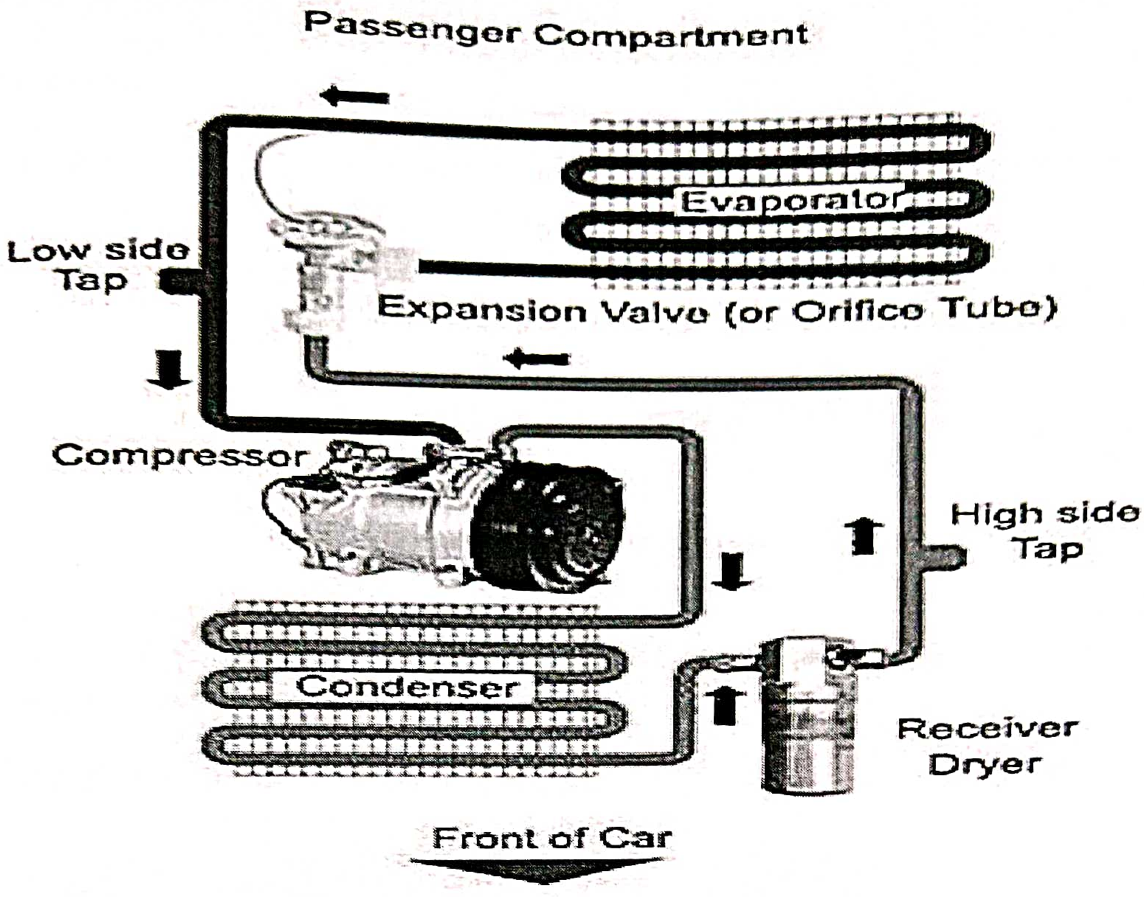


Fig1.1: Simple Vapor Compression Refrigeration System

CHAPTER 2: DESIGN AND DIMENSION

2.1 Introduction

As we want create a new type of Air Conditioner, our main challenge is to compact the size. After a series of soft designing and analyzing we have come to a conclusion.

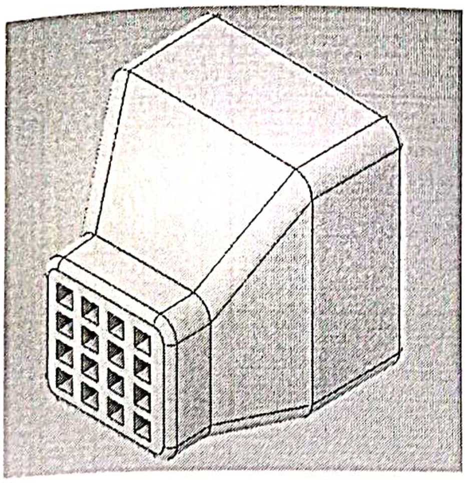


Fig 2.1: 3-D design of casing

The main features of this design are:

- Easy to assemble and dissemble.
- All components are integrated into single structure.
- Easy to carry from one place to the other.
- Comfortable handling

2.2 Main Benefit

1. No Restriction
   There is restriction of relocation. It could be easily place from one room to the other room.
2. A Small Unit for a Small Space
   Portable AC is perfect if the space available is small. It could be adjusted in a very small room or a studio.
3. Cut Cost and Keep Cool
   Portable AC could be used could be used for economical reason as well. They are great supplement to normal AC which takes heavy consumption of electricity.
4. Alternative On-the-GO Cooling
   The travelers could carry the AC along with him/her. It could be used in camps, tents or in open nature.

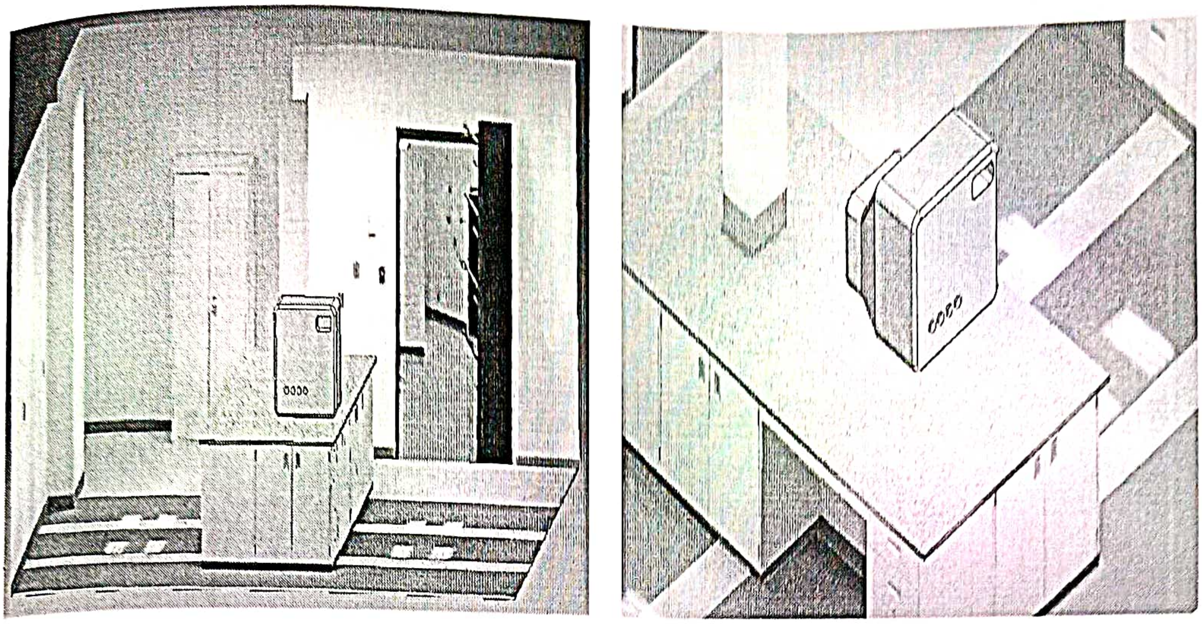


Fig 2.2: Real environment of Air conditioner

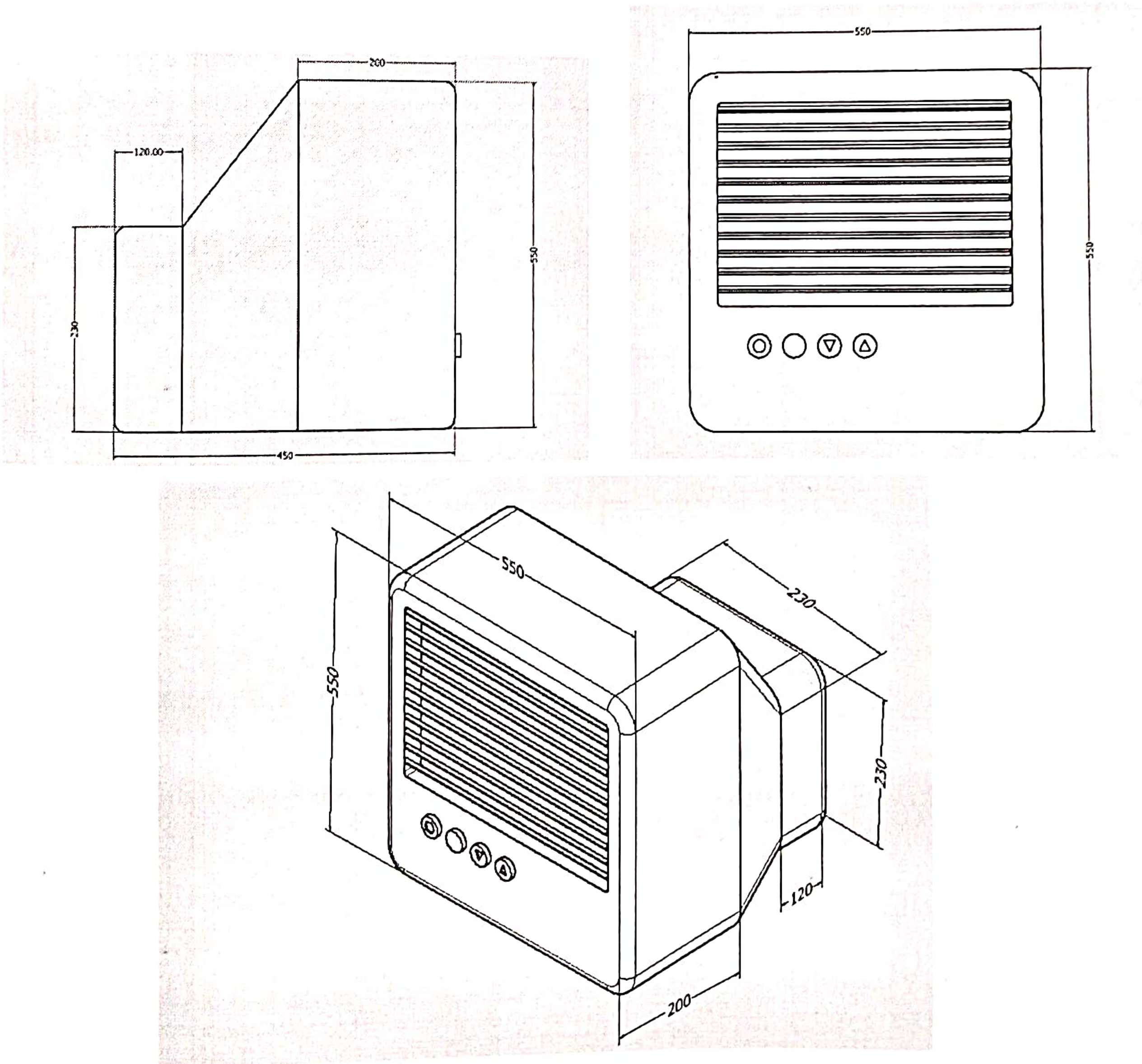


Fig 2.3: Dimension of AC (**all dimensions are in centimeter (cm).)

2.3 Dimensions of AC

The dimension of the AC could be reduced further but due to tolerance its final dimension is shown below:

- Front panel is of 60 by 60 cm.
- It extruded to 26 cm.
- Back portion is of 40 by 35 cm.
- It is having a height of 12 cm.
- The middle portion lofted with a distance of 28 cm.

2.4 Drawing Views of Air Conditioner

- Front view shows the controlling panel. There is four buttons for adjustment and small rectangle at right top corner is cooling duct.
- Bigger cuboids contain compressor, driving motor, cooling coil, drier and filter and axial blower fan as shown by side or top view.
- Smaller cuboids contain condenser and condenser cooling fan.
- In-between both cuboids there are connecting pipes and other electrical and mechanical connection.

*these views are scale at 1:0.25

2.5 Component Position Description

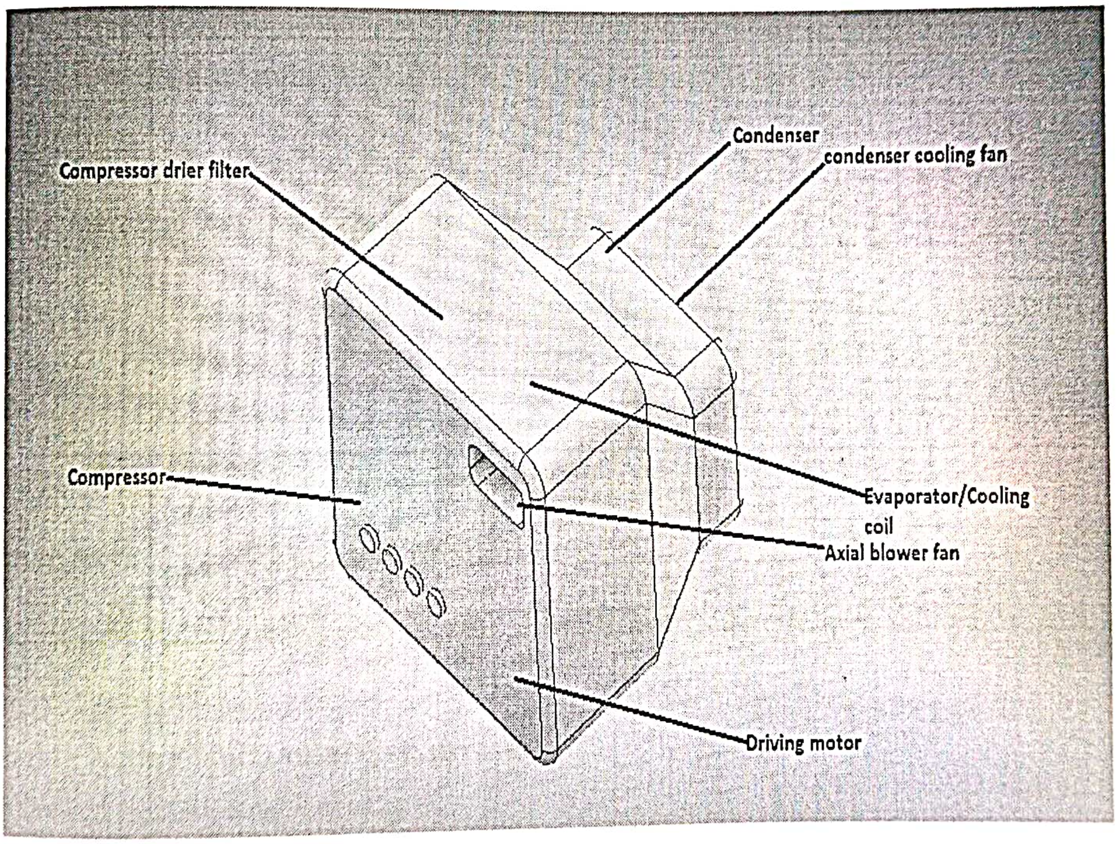


Fig 2.5 Component position description

CHAPTER 3: COMPRESSOR

3.1 Introduction:

- The compressor is the work horse of the air-conditioning system, powered by a drive belt connected to the crank-shaft of the engine.
- When the air-conditioning system is turned on, the compressor pumps refrigerant vapour under high pressure to the condenser.
- It is used to compress the vapour refrigerant from the evaporator and to raise its pressure so that the corresponding saturation temperature is higher than that of cooling medium.
- It also continually circulates the refrigerant through the ac system.
- Since the compression of refrigerant requires some work to be done on it, therefore, a compressor must be driven by some prime mover.

3.2 RECIPROCATING COMPRESSOR

A reciprocating air compressor is one which reciprocates inside a cylinder (liner) unit. The piston moves up and down continuously to pump the air after compression into the air receiver.

There are two types of reciprocating compressor:

1. **Single Acting Vertical Compressor:**

These compressors usually have their cylinders arranged vertically, radially or in a V or W form.

2. **Double Acting Horizontal Compressor:**

These cylinders usually have their cylinders arranged horizontally

3.3SWASH PLATE COMPRESSOR

- In this compressor, the piston is constructed from the components as shown in the figure.

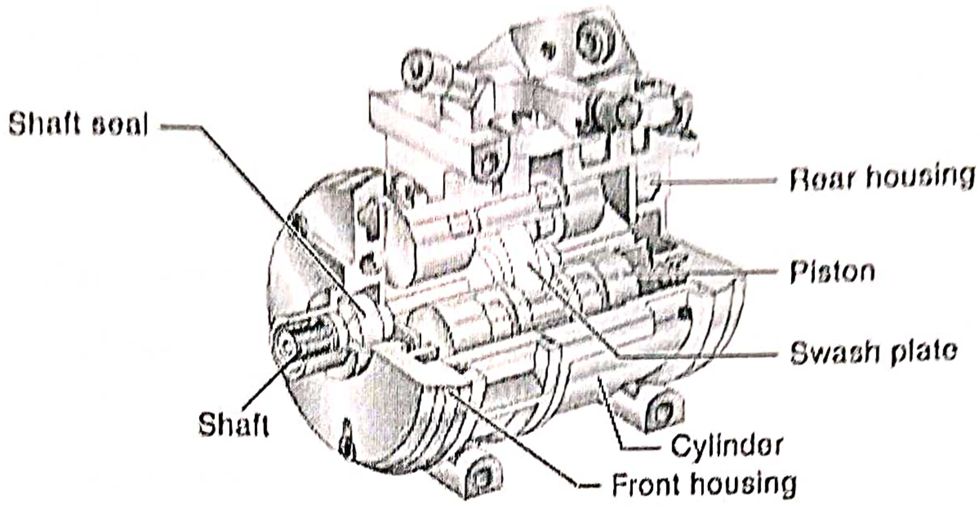


Fig: 3.1 Schematic Diagram of Swash Plate Compressor

- The piston moves back and forth when power from the motor causes the shaft and swash plate to rotate.
- One piston is comprised of cylinders on both sides. The ends of the piston intake pressurize and discharge refrigerant.

3.3.1 WORKING

- The suction valve is opened when the piston moves to the left. The pressure difference between the suction valve within the housing and inside the cylinder causes refrigerant to enter the cylinder through the suction valve.
- Conversely when the piston moves to the right , the suction valve gets closed and the refrigerant is pressurized.
- Continued pressurization increases the pressure of the refrigerant in the cylinder, causing the discharge valve to open.
- The refrigerant then flows to a high-pressure pipe(The suction and discharge valves prevent flow back of the refrigerant).
- The swash plate angle can be adjusted, which forces the piston to make larger or smaller strokes. This enables stable temperature control.

3.3.2 SPECIFICATIONS OF COMPRESSOR UTILIZED IN PROJECT

- Manufacturing Company: **Subros Limited**
- Model No.: **10P08**
- Type: **Swash Plate**
- Number of Pistons: **5**
- Compressor Oil: **Denso-8**
- Mountings: **3**
- Type of Pulley: **Single Groove**
- Recommended Refrigerant: **R134a**

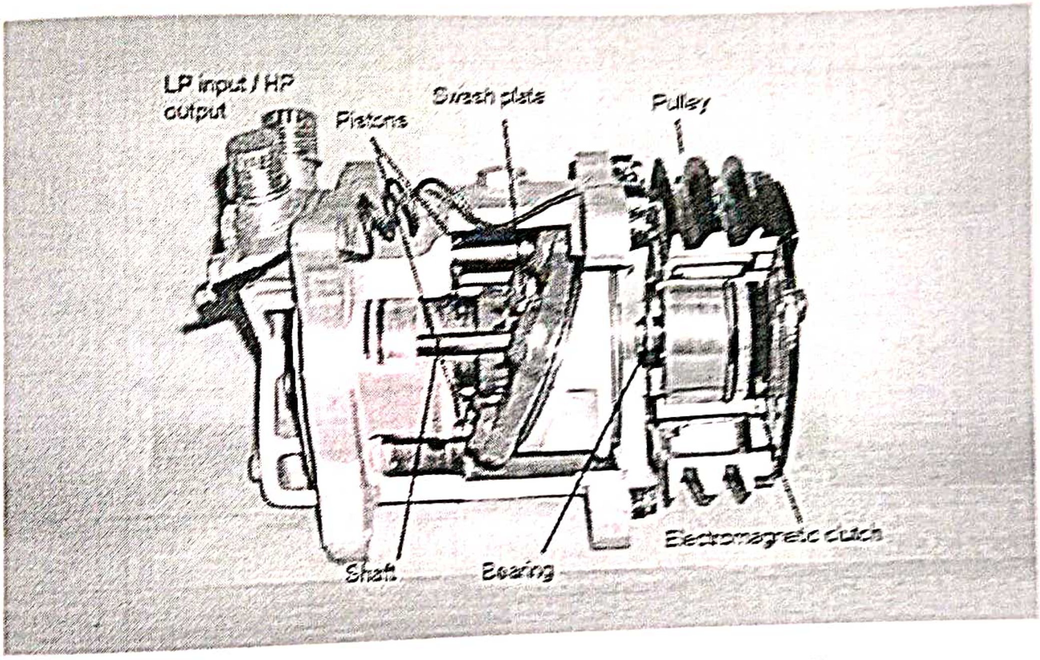


Fig: 3.2 Actual Schematic Diagram of Swash Plate Compressor

CHAPTER 4: What is condenser?

4.1 Introduction

In systems involving heat transfer, a condenser is a device or unit used to condense a substance from its gaseous to its liquid state, by cooling it. In so doing, the latent heat is given up by the substance and transferred to the surrounding environment

Condensers are used in air conditioning, industrial chemical processes such as distillation, steam power plants and other heat-exchange systems. Use of cooling water or surrounding air as the coolant is common in many condensers.

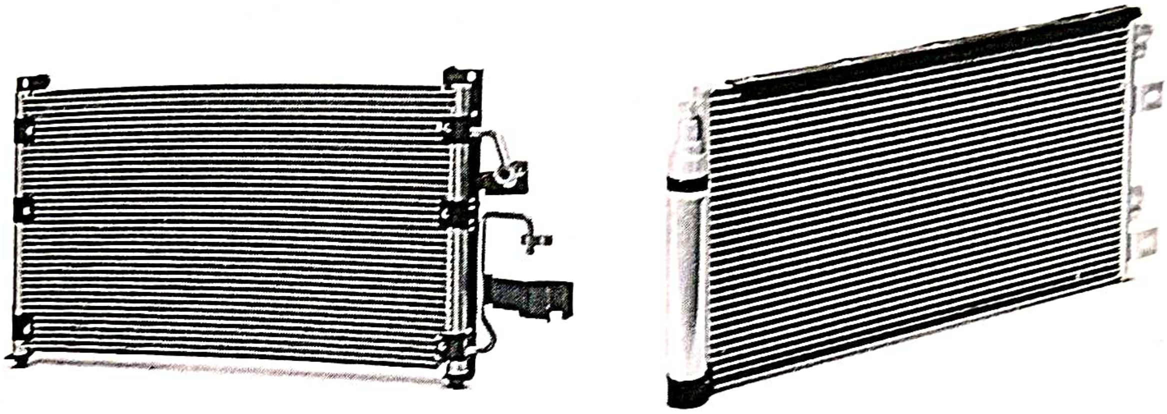
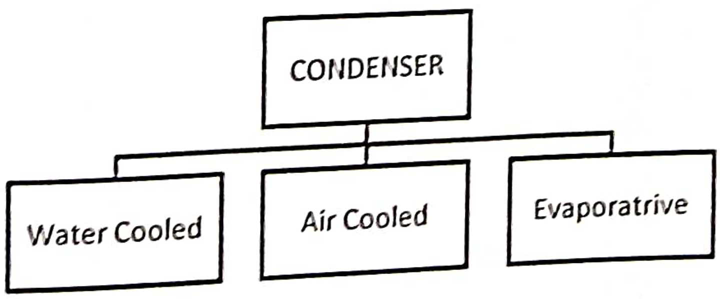


Fig 4.1: Condenser

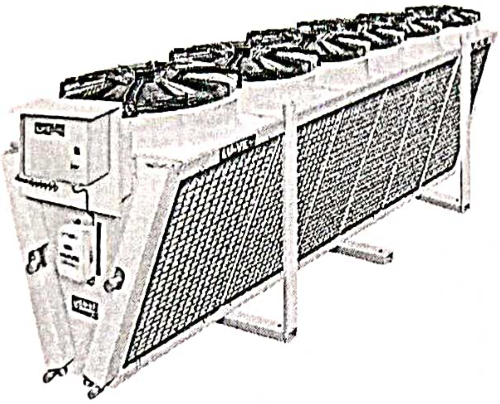
4.2 Types of Condenser



4.2.1 Air cooled

If the condenser is located on the outside of the unit, the air cooled condenser can provide the easiest arrangement. These types of condensers eject heat to the outdoors and are simple to install.

Most common uses for this condenser are domestic refrigerators, upright freezers and in residential packaged air conditioning units. A great feature of the air cooled condenser is they are very easy to clean. Since dirt can cause serious issues with the condensers performance, it is highly recommended that these be kept clear of dirt.



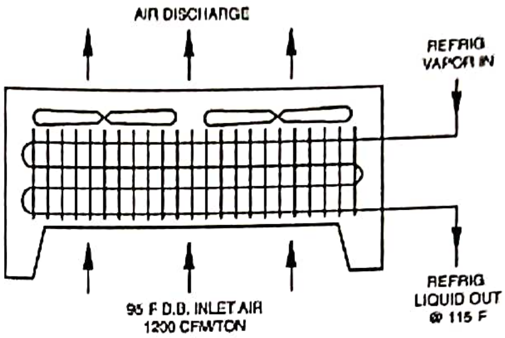


Fig4.2: Shows the air cooled condenser

4.2.2 Water cooled –

Although a little more pricey to install, these condensers are the more efficient type. Commonly used for swimming pools and condensers piped for city water flow, these condensers require regular service and maintenance.

They also require a cooling tower to conserve water. To prevent corrosion and the forming of algae, water cooled condensers require a constant supply of makeup water along with water treatment. Depending on the application you can choose from tube in tube, shell and coil or shell and tube condensers. All are essentially made to produce the same outcome, but each in a different way.

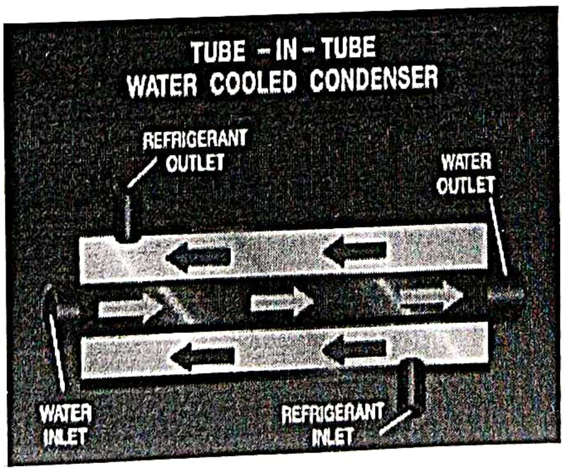


Fig 4.3:- water cooled condenser

4.2.3 Evaporative –

While these remain the least popular choice, evaporative condensers can be used inside or outside of a building and under typical conditions, operate at a low condensing temperature

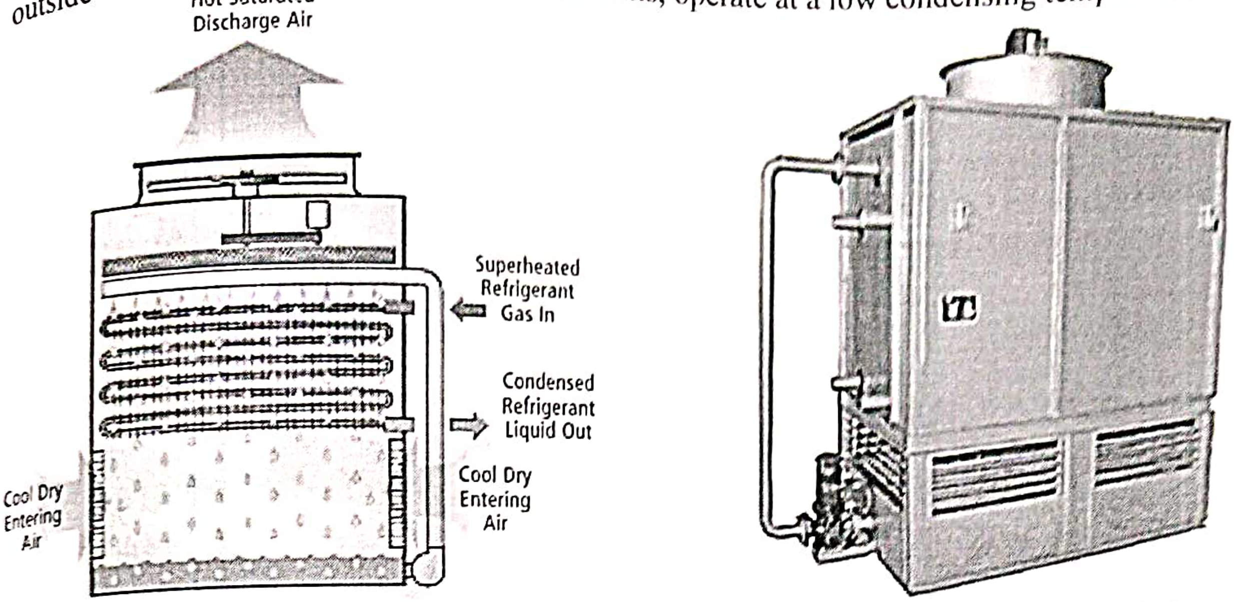


Fig 4.4:

Evaporative condenser

4.3WHY WE USE AIR COOLED CONDENSER???

4.3.1 INSTALLATION

- Why does location feature so prominently when installing both systems? The reason is that failing on this aspect can lead to a perpetual recirculation problem in water-cooledsystems. For a tower sited in an awkward position, for instance a hole, it is important to consult Araner for advice from the tower selection stage.
- Installation of air-cooled systems should be in such a way that no obstruction occurs to airflow on both the air discharge and air intake sides. Avoid placing the condenser near a wall or ceiling to prevent air obstruction

4.3.2 MAINTENANCE

- Air cooled heat rejection systems are almost maintenance free. Only sporadic periodic cleaning of air condenser coils might be needed if the air-cooled system is operating in a dirty environment in order to avoid the fouling
- When water evaporates from a cooling tower, it leaves behind all its solid matter. The only way to deal with this problem is to add water to the tower periodically to compensate for the lost water in a process which is called blow down
- Generally, maintenance of this system is much more demanding than for an air-cooled system.

4.3.3 OPERATING COST

- Traditionally, water-cooled chillers are considered to be much more efficient than air cooled chillers and this is correct for most of the cases and for design conditions. Out of the design conditions the dry bulb temperature is reduced a lot, however the wet bulb temperature is not reduced that much. This means that out of the design conditions the difference in efficiency is not that high and might not justify the water consumption.
- For this case and similar ones, if we make the study of the DC plant all around the year and not only for design conditions; we can see that the extra electrical consumption of the air cooled option is negligible while the savings in water consumption are very important.

4.4 COMPARISON OF WATER-COOLED AND AIR-COOLED SYSTEM

Utilities Consumption for		
Parameters	**Water Cooled Chillers**	**Air Cooled Chillers**
Heat Rejection Devices	Cooling Towers	Dry Condensers with Direct Condensation
Yearly Energy Consumption	30,978,219 kW·h	31,520,536 kW·h
Yearly Average Efficiency	0.62 kW/TR	0.63 kW/TR
Yearly Water Consumption	497,204 m3	ZERO
Chemical consumption	YES	ZERO

CHAPTER 5: FILTER DRIER

5.1 Introduction

Receiver-driers, also called filter-driers, are located between the condenser and the TX valve. They are intelligently named because of the way they 'filter' fine debris and 'dry' moisture from the system

5.2 Types of filter drier

There are basically two types in used today.

1. Liquid Line Type

2. Suction Line Type

5.2.1 Liquid Line Type

It is placed after the condenser coil and before the expansion valve. The liquid refrigerant that flows from the condenser to the expansion valve is filtered from particles and moisture before entering it.

5.2.2 Suction Line Type

Suction Line Type is placed after the evaporator and before the compressor. This device is used to protect the compressor especially after any failure that contaminates the system. Motor failure in the compressor usually because acid and other contaminants to be introduced into the refrigerant system hence it is important to have the suction line filter dryer installed.

5.3 Important function of drier filter

- Receiver/driers serve three very important functions:
- They act as a temporary storage containers for oil and refrigerant when neither are needed for system operation (such as during periods of low cooling demand). This is the "receiver" function of the receiver/drier.
- Most receiver/driers contain a filter that can trap debris that may be inside the A/C system.
- Receiver/driers contain a material called desiccant. The desiccant is used to absorb moisture (water) that mayhave gotten inside the A/C system during manufacture, assembly or service. Moisture can get into the A/C components from humidity in the air. This is the "drier" function of the receiver/drier.

CHAPTER 6: Expansion Valves

6.4 Introduction

Expansion valves are devices used to control the refrigerant flow in a refrigeration system. They help to facilitate the change of higher pressure of liquid refrigerant in the condensing unit to lower pressure gas refrigerant in the evaporator. The term "low side" is used to indicate the part of the system that operates under low pressure, in this case the evaporator. The "high side" is used to indicate the part of the system that operates under high pressure, in this case the condenser.

6.2 Types of Expansion Valves

There are basically four types of valves that are in used. These valves are also referring to as metering devices.

- Automatic Exp. Valves
- Thermostatic Exp. Valves
- Capillary Tubes
- Float

Valves

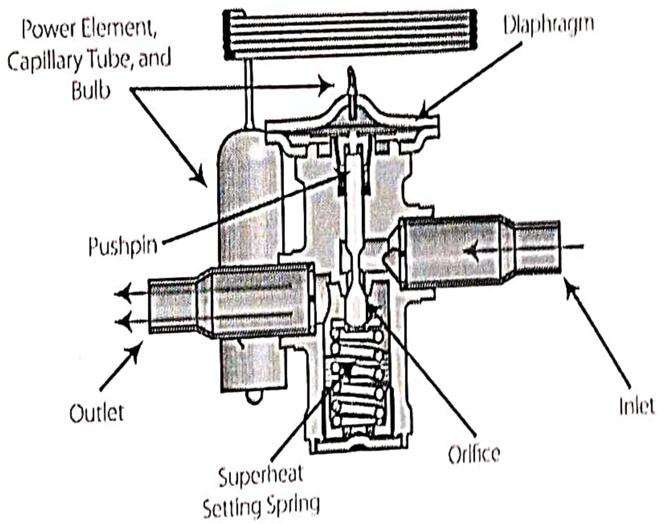


Fig. 6.1: Expansion valve

6.2.1 Automatic Expansion Valve

Regulates the flow of refrigerant from the liquid line to the evaporator by using a pressure-actuated diaphragm. It maintains a constant pressure in the evaporator. The setback is that it is not efficient if the load fluctuates hence this type is not suitable for use in air conditioning as the load fluctuates a lot during its operation.

6.2.2 Thermostatic Expansion Valve

Uses a valve mechanism to control the flow of liquid refrigerant into the evaporator coil. The flow is controlled by the pressure in the evaporator.This type of metering device is able to operate well when the load fluctuates and hence is suitable for use in air conditioning system. When the evaporator warms, the valve provides a higher flow rate and when it cools, it reduces the flow rate. It is also commonly refer to as TXV, TEV or TX valve. There is a sensing bulb which detects the temperature of the coil and is usually located at a higher temperature within the evaporator. The bulb must be clamped firmly to the coil to ensure proper sensing. When the temperature of the evaporator increases due to the demand for cooling, the pressure in the bulb will also increase hence pushes the spring to open the valve. Similarly, when the temperature of the evaporator reduces due to a lack of demand for cooling, the pressure in the bulb will drop hence causing the spring to close the valve.

6.2.3 Capillary Tube

Capillary tube is a tube with small internal diameter and could be coiled for part of its length. It is installed to the suction line. A filter-drier is sometimes fitted before the tube to remove dirt or moisture from the refrigerant. This device is simple, does not have any moving part and lasts longer. In order to use this device, the amount of refrigerant in the system must be properly calibrated at factory level.
Due to its lower cost compared to TXV, this metering device is used in units that are produced in large quantity such as room or window air conditioners.

Depending on the capacity design of the system, the capillary tube internal diameter that is commonly used range from 0.031" to 0.065" and the outer diameter from 0.083" to 0.130".

6.2.4 Float Valve

Float valve is actuated by a float that is immersed in the liquid refrigerant. Both low-side float and high side-float are used to control the flow of liquid refrigerant. The low-side float helps to maintain a constant level of liquid refrigerant in the evaporator. It opens when there is no liquid in the evap. and closes when there is liquid in the evap. The high-side float is located at the high pressure side of the system and maintains a constant level of refrigerant in the condenser. When the compressor operates, the condensed refrigerant flows to the float chamber and opens the valve.

This causes the refrigerant to flow into the evaporator where it is stored. As the liquid level falls in the float chamber, the valve opening will close hence preventing the liquid from flowing to the evaporator.

CHAPTER 7: EVAPORATOR

7.1: Introduction

The evaporator, also sometimes referred to as the evaporator core, is one of the two (maybe three) heat exchangers in a mobile A/C system. In a typical passenger car or pickup truck, the evaporator is usually located inside the passenger compartment, quite often deeply buried in or under the instrument panel. Some vehicles, usually vans or SUVs, have two evaporators; one under the instrument panel, or elsewhere at the front of the vehicle, and another one located in or toward the rear of the vehicle. The rear evaporator is often located behind a side panel or in the ceiling above the rear passengers.

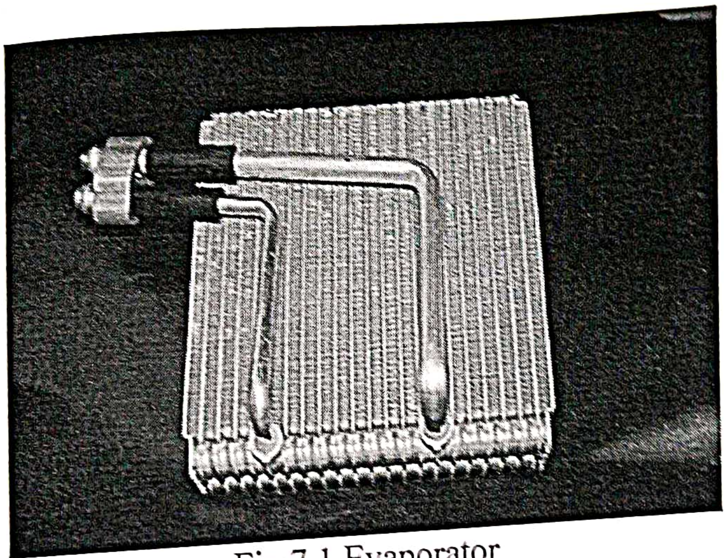


Fig.7.1 Evaporator

Evaporators are usually made of aluminum. They look like, and in fact are, similar to radiators, only thicker and smaller in overall size. Like radiators, evaporators consist of a series of internal tubes or "flow paths" with fins attached to them. Air can pass freely through the fins, just like a radiator. But unlike a radiator, where the internal tubes carry moving engine coolant, the passages in the evaporator carry moving refrigerant. When many people talk about refrigerant, they refer to it by its most popular brand name from years back, "Freon,™" or R-12. In the United States, Freon™/R-12 was the type of refrigerant used in mobile A/C systems until about 1994, but it was replaced with a different refrigerant in all vehicles after the 1995 model year. The new refrigerant is HFC-134a (or R-134a).In a mobile A/C system, cold, low-pressure liquid refrigerant enters the evaporator. Warm air from the interior of the vehicle passes through the evaporator by action of the blower fan. Since it`s a fact of nature that heat always travels from a warmer area to a cooler area, the cooler refrigerant flowing inside the evaporator's absorbs heat from the warm air. At the same time, humidity in the air condenses on the cool evaporator's surface, then eventually drips out of a drain tube to outside the vehicle this is why you see water dripping underneath a car while the air conditioner is on. After the (now slightly warmer) refrigerant has completed its path through the evaporator, it moves on to the compressor. So, as you can see, air conditioning does not actually cool the interior of the vehicle. What it really does is remove heat and humidity from it.

Pressures of Evaporator:-

Refrigerant	P_g (kappa)	ρ_f (kg m^{-1})	ρ_g (kg m^{-1})	h_{fg} (kJ kg^{-1})	k_f (W m^{-1} K^{-1})	μ_f (μPa s)	dT_{sat}/dP (K kPa^{-1})	GWP (100 years)
R134a	374.6	18.32	1271.3	193.2	0.0889	243.88	0.0770	1320

Table 7.1 Evaporator design information.

Items	Unit	Value
Tube length	mm	500
Tube inside diameter	mm	9.2
Tube outside diameter	mm	10.0
Tube spacing	mm	25.4
Tube row spacing	mm	22.2
Number of tubes per row		12
Number of depth rows		3
Fin thickness	mm	0.2
Fin spacing	mm	2
Tube inner surface		Smooth
Fin geometry		Louver
Air volumetric flow rate	$m^3\ min^{-1}$	25.5

CHAPTER 8: REFRIGENTS

8.1 Introduction

- A refrigerant is a substance or mixture, usually a fluid, used in a heat pump and refrigeration cycle. In most cycles it undergoes phase transitions from a liquid to a gas and back again.
- Many working fluids have been used for such purposes. Fluorocarbons, especially chlorofluorocarbons, became commonplace in the 20th century, but they are being phased out because of their ozone depletion effects.
- Refrigerants absorb heat at low temperature and low pressure and release heat at a higher temperature and pressure

8.2 Primary and secondary refrigerants:

- Primary refrigerants are those fluids, which are used directly as working fluids, for example in vapour compression and vapour absorption refrigeration systems. When used in compression or absorption systems, these fluids provide refrigeration by undergoing a phase change process in the evaporator.
- Secondary refrigerants are those liquids, which are used for transporting thermal energy from one location to other. Secondary refrigerants are also known under the name brines or antifreezes.

8.3 Refrigerant selection criteria:

i. Thermodynamic and thermo-physical properties

ii. Environmental and safety properties, and

iii. Economics

8.4 Thermodynamic and thermo-physical properties:

a) **Suction pressure:** At a given evaporator temperature, the saturation pressure should be above atmospheric for prevention of air or moisture ingress into the system and ease of leak detection. Higher suction pressure is better as it leads to smaller compressor displacement

b) **Discharge pressure:** At a given condenser temperature, the discharge pressure should be as small as possible to allow light-weight construction of compressor, condenser etc.

c) **Pressure ratio:** Should be as small as possible for high volumetric efficiency and low power consumption.

d) **Latent heat of vaporization:** Should be as large as possible so that the required mass flow rate per unit cooling capacity will be small.

8.5 Essential Properties of Refrigerants

- Chemical stability under conditions of use is the most important characteristics.
- Safety codes may require a nonflammable refrigerant of low toxicity for most applications.
- Cost, availability, efficiency, and compatibility with compressor lubricants and materials with which the equipment is constructed are other concerns.
- Latent heat of vaporization is another important property.

8.6 Environmental and Safety Properties

- Ozone Depletion Potential (ODP): According to the Montreal protocol, the ODP of refrigerants should be zero, i.e., they should be non-ozone depleting substances.
- Refrigerants having non-zero ODP have either already been phased-out (e.g. R 11, R 12) or will be phased-out in near-future (e.g. R22).
- Since ODP depends mainly on the presence of chlorine or bromine in the molecules, refrigerants having either chlorine (i.e., CFCs and HCFCs) or bromine cannot be used under the new regulations.
- Based on the above criteria, ASHRAE has divided refrigerants into six safety groups (A1 to A3 and B1 to B3).
- Refrigerants belonging to Group A1 (e.g. R11, R12, R22, R134a, R744, R718) are least hazardous, while refrigerants belonging to Group B3 (e.g. R1140) are most hazardous.

8.7 R134a as Replacement for R12

- Power required per ton of refrigeration:
- Low temperature application
- Heat transfer coefficients
- Miscibility of R134a with oil
- Refrigerating effect per pound of refrigerant

➢ Advantages

- R134a refrigerant is an eco-friendly refrigerant.
- It is uninflammable, non-explosive, and non-toxic.
- R134a has better heat conductivity.
- R134a refrigerant has no strange stench.

CHAPTER 9: ELECTRICAL CONNECTION AND ITSS CONTROL SYSTEM

9.1 Introduction:

The main control board can be divided into input power supply, a microcomputer controller integrated circuit, temperature sensor inputs and outputs to control the compressor, indoor fan speed, outdoor fan speed and air swing. The AC input from the mains has to be converted to DC voltage where it can be used to power the integrated circuits and drivers in the electronics circuit.

There are two ways to do this. One is by using a step down transformer where the AC voltage is stepped down to voltage such as 25V AC or 12V AC. This voltage is then converted to DC by the use of Diode Bridge as rectified voltage.

A 3-pin voltage regulator is used to get a fixed 5V DC or 12V DC power and electrolytic capacitor to smoothen the rectified voltage supply. This low voltage is used to power the microcomputer, DC relays and other integrated circuits in the circuit.

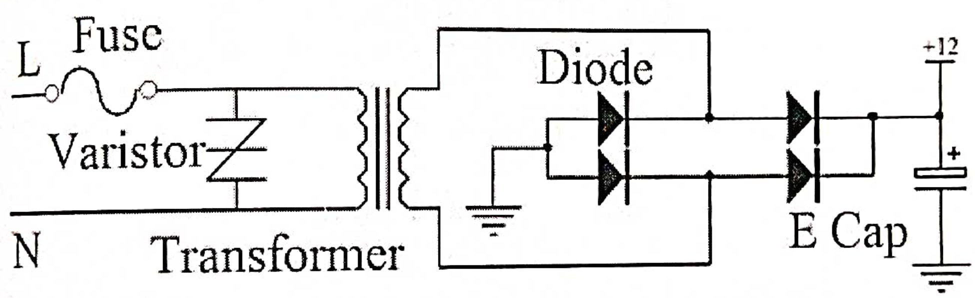


Fig. 9.1 A simple linear power supply circuit.

9.2 Element of Electronic control unit:-

1. Micro-controller (Arduino Uno)
2. Display
3. DHT11 Sensor
4. Freeze protection Sensor
5. Varistor
6. 12VDC Power supply
7. Voltage regulator
8. Fuse
9. Relay

9.2.1 Micro-controller

A micro-controller(Arduino Uno) is a small computer on a single integrated circuit containing a processor core, memory, and programmable input/output peripherals .The important part for us is that a micro-controller contains the processor(which all computers have) and memory, and some input/output pins that you can control. (Often called GPIO - General Purpose Input Output Pins).

Arduino is a single-board microcontroller to make using electronics in multidisciplinary projects more accessible. The hardware consists of a simple open source hardware board designed around an 8-bit Atmel AVR microcontroller, or a 32-bit Atmel ARM. The software consists of a standard programming language compiler and a boot loader that executes on the microcontroller.

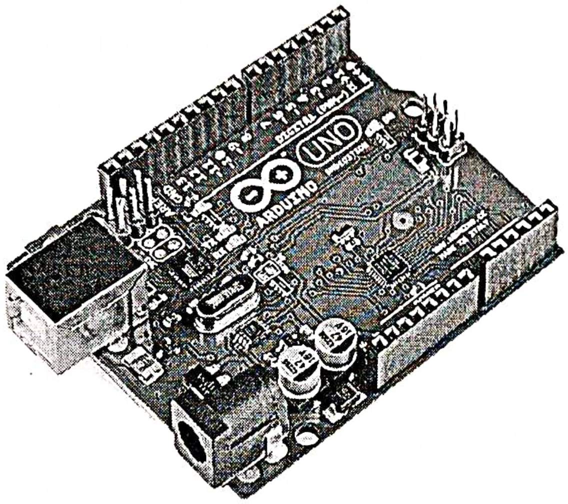


Fig. 8.2 **Arduino Uno**

9.2.1.1 Hardware Specification of Arduino Uno

1. Microcontroller: ATmega328
2. Operating Voltage: 5V
3. Input Voltage (recommended):7-12V
4. Input Voltage (limits): 6-20V
5. Digital I/O Pins: 14 (of which 6 provide PWM output)
6. Analog Input Pins: 6
7. DC Current per I/O Pin: 40mA
8. DC Current for 3.3V Pin: 50mA
9. Flash Memory: 32 KB (ATmega328)
10. SRAM: 2 KB (ATmega328)
11. EEPROM: 1 KB (ATmega328)
12. Clock Speed: 16 MHz

9.2.2 Display

The Display unit shows the visual graphic of temperature, humidity, power indicator and Receiver indicator. Display unit is based on OLED technology.OLED panels are made from organic (carbon based) materials that emit light when electricity is applied through them. Since OLEDs do not require a backlight and filters (unlike LCD displays), they are more efficient, simpler to make, and much thinner - and in fact can be made flexible and even rollable. OLEDs have a great picture quality - brilliant colors, infinite contrast, fast response rate and wide viewing angles. OLEDs can also be used to make OLED lighting - thin, efficient and without any bad metals.

9.2.3 DHT11

This DHT11 Temperature & Humidity Sensor features a temperature & humidity sensor complex with a calibrated digital signal output. By using the exclusive digital-signal-acquisition technique and temperature & humidity sensing technology. This sensor includes a resistive-type humidity measurement, and connects to a high- performance 8-bit microcontroller, offering excellent quality, fast response, anti-interference ability and cost-effectiveness.

(Each DHT11 element is strictly calibrated in the laboratory that is extremely accurate on humidity calibration. The calibration coefficients are stored as program in the OTP memory, which are used by the sensor's internal signal detecting process. The single-wire serial interface makes system integration quick and easy. Its small size, low power consumption and up-to-20 meter signal transmission making it the best choice for various applications, including those most demanding ones. The component is 4-pin single row pin package. It is convenient to connect and special packages can be provided according to users' request.)

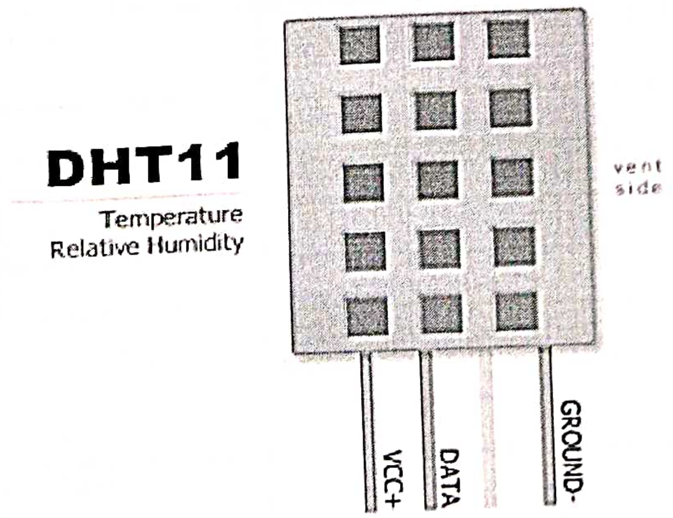


Fig. 9.3 DHT11 Sensor

9.2.3.1 Technical Specification

8.2.3.1.1 Overview Specification

Item	Measurement Range	Humidity Accuracy	Temperature Accuracy	Resolution	Package
DHT11	20-90%RH 0-50 ℃	±5%RH	±2℃	1	4 Pin Single Row

8.2.3.1.2 Detailed Specification

Parameters	Conditions	Minimum	Typical	Maximum
Humidity				
Resolution		1%RH	1%RH	1%RH
			8 Bit	
Repeatability			±1%RH	
Accuracy	25℃		±4%RH	
	0-50℃			±5%RH
Interchangeability	Fully Interchangeable			
Measurement Range	0℃	30%RH		90%RH
	25℃	20%RH		90%RH
	50℃	20%RH		80%RH
Response Time (Seconds)	1/e(63%)25℃, 1m/s Air	6 S	10 S	15 S
Hysteresis			±1%RH	
Long-Term Stability	Typical		±1%RH/year	
Temperature				
Resolution		1℃	1℃	1℃
		8 Bit	8 Bit	8 Bit
Repeatability			±1℃	
Accuracy		±1℃		±2℃
Measurement Range		0℃		50℃
Response Time (Seconds)	1/e(63%)	6 S		30 S

9.2.4 Freeze protection Sensor

Freeze protection sensor is designed to be used in preventing evaporator from freezing and measuring temperature needed for regulation of return refrigerant. Controlling the temperature of the evaporator is one of the most important functions of temperature sensors in air-conditioning systems. Because the evaporator is the coolest point encountered by the stream of air coming from the passenger compartment, this is where most of the condensation is formed due to the low absorption of moisture by the air. It would freeze at temperatures around 0 °C and thus obstruct the air stream. The evaporator sensor would then measure a higher temperature than the real temperature of the air coming from the evaporator. The air-conditioning unit would then continue to cool the air despite the fact that the evaporator was already iced up.

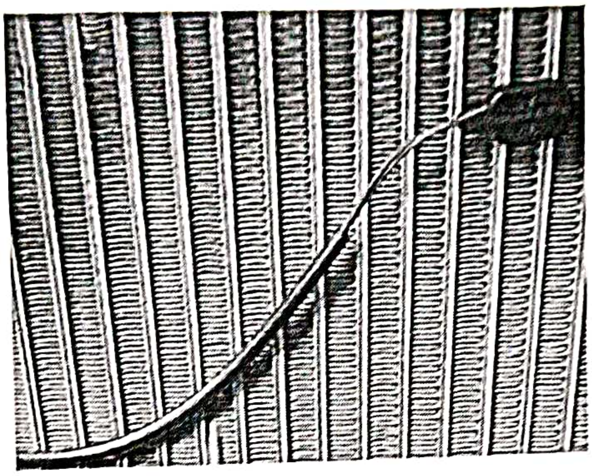


Fig.9.4 Freeze protection sensor in evaporator

9.2.5 Varistor

A varistor is a voltage dependent resistor (VDR). The resistance of a **varistor** is variable and depends on the voltage applied. In case of excessive voltage increases, their resistance drops dramatically. This behavior makes them suitable to protect circuits during voltage surges. Causes of a surge can include lightning strikes and electrostatic discharges. The most common type of VDR is the metal oxide varistor.

9.2.612VDC Power supply

12 volt and 2Amp power supply is used to operate the evaporator fan, condenser fan and clutch of compressor. The power supply comes from AC source (220v) is converted into 12v by using small transformer.

9.2.7 Voltage regulator

In this system electronic voltage regulator is used to divide the voltage in 5v and 3.3v for power supplies of micro-controller, DHT11 sensor, Display unit and Freeze protection sensor.

9.2.8 Fuse

Electrical connection between AC source and the transformer, a fuse is an electrical safety device that operates to provide overcurrent protection of an electrical circuit. The rating of fuse used in this system is 1KW (220v-5A)

9.2.9 Relay

A relay is an electronically operated switch by instruction of Micro-controller.

9.2.9.1 Technical Specification

Features	Dimension L * W * H (mm)	19 * 15.5 * 15.5			
	Terminal Type	PCB			
	Weight	10.5 gm Approximately			
Contact Data	Contact Form	1C			
	Contact Material	Ag Alloy			
	Contact Capacity	7A @ 240VAC			
Coil Data	Coil Voltage (DC)	6 ~ 48 VDC			
	Coil Power Consumption	0.36W			
	Coil Specification	Coil Voltage	Coil Resistance (Ω) ±10%	Pull in Voltage (VDC)	Drop Out Voltage (VDC)
		6 VDC	100	80%	5%
		12 VDC	400	80%	5%
		24 VDC	1600	80%	5%
General Data	Dielectric Strength	750 VAC @ 50 Hz / Min (Between Open Contacts)			
		1500 VAC @ 50 Hz / Min (Between Coil & Contacts)			
	Insulation Resistance	100MΩ			
	Electrical Life	1×10^5			
	Mechanical Life	1×10^7			
	Operating Temperature	- 40 °C ~ + 70°C			

9.3 Flow Diagram

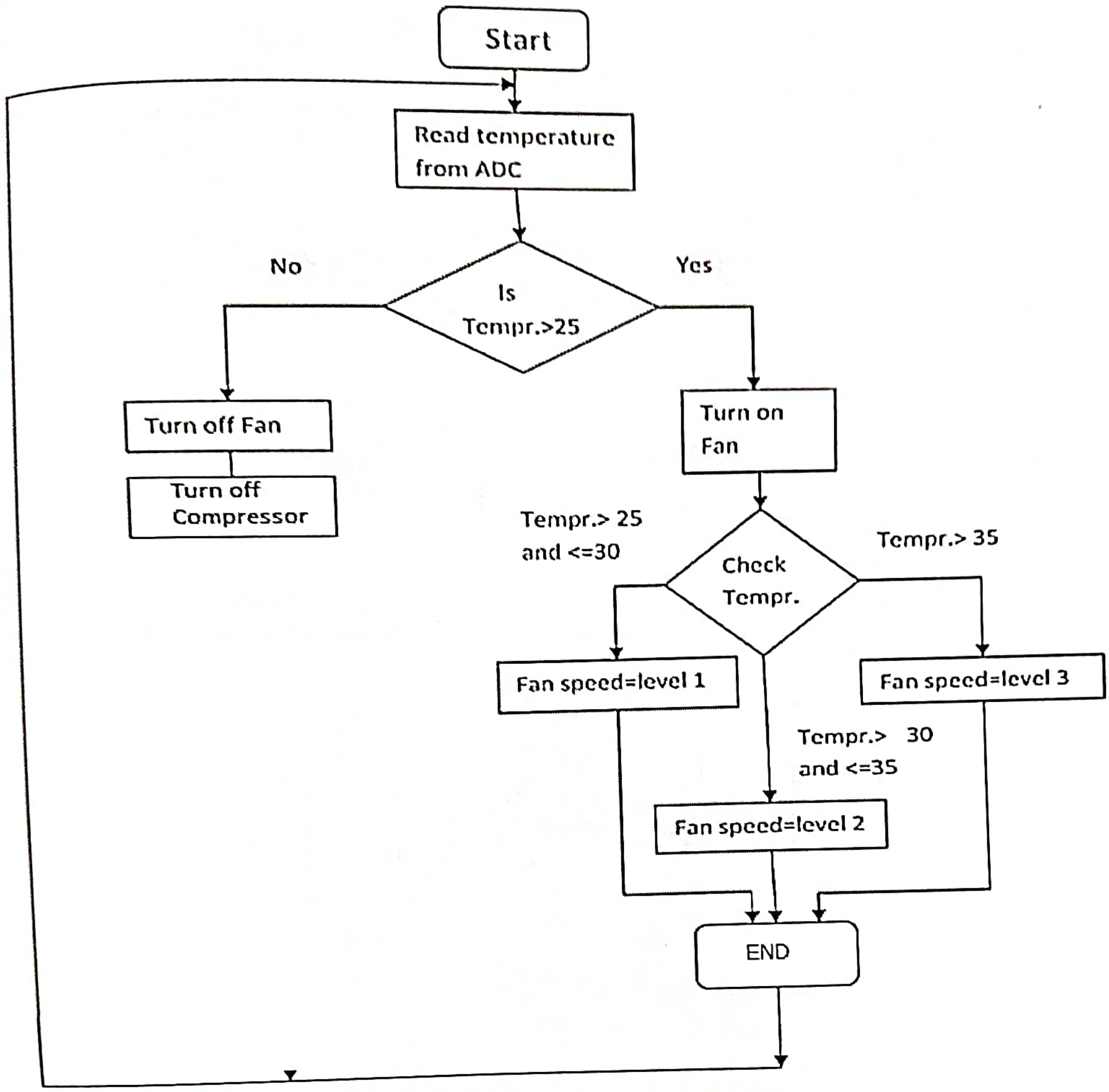


Fig.9.5 Flow chart of Fan speed Controlling

Calculation Coefficient of Performance

Sr. no	Initial pressure P_1 (bar)	Final pressure P_2 (bar)	Temp. T_2 (K)	h_1 (kj/kg)	h_2 (kj/kg)	h_{f3} (kj/kg)	COP = $\frac{h_1-h_{f3}}{h_2-h_1}$
1	2	12	49	395	435	265	3.25
2	2	11.8	45.62	395	421.74	264.87	4.87
3	2	11.6	45	395	421.5	263.9	4.94
4	2	11.5	44.65	395	421.35	263.38	4.99
5	2	11	42	395	420	260	5.4

P_1= Inlet pressure of compressor
P_2= Pressure after compressor
T_2= Temperature of condenser at outlet
h_1=Inlet enthalpy of refrigerant of compressor
h_2=Outlet enthalpy of refrigerant at compressor
h_{f3}=Outlet enthalpy of refrigerant at condenser

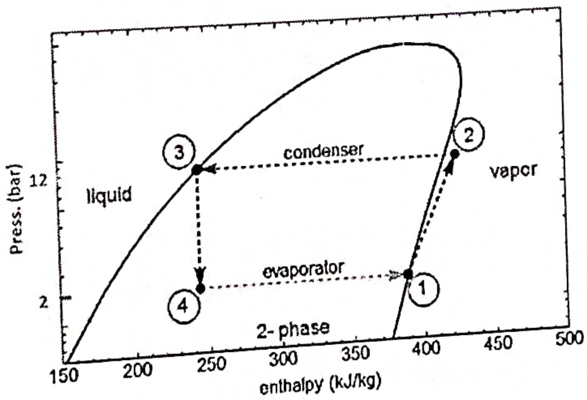


Fig: 1 refrigeration cycle of compact AC

Comparison of Ton

Btu/h	Refrigeration Ton	kW
6000	1/2	1.76
12000	1	3.52

Calculating EER, the ratio of the heat (thermal energy) removal to the electrical energy required to move it by the compressor, condenser and evaporator fans. Using our system calculations below:

1 refrigeration ton = 12,000BTU = 3.5KW

P = Electrical power rating of the A/C system = 0.786 KW

C = System capacity = 0.786 tons x 3.5 = 2.751KW

EER = C / P

11.2 / 0.786 = 3.5

Mass flow rate (m) = 210/Net refrigerant effect

$m=210/(h_1-h_2)*60$

$m=210/40*60 = 0.0875$ kg/sec.

Compressor work (w_s) = $m*(h_1-h_2)$.

1. Comparison of conventional AC and Compact AC

Sr. no.	PARAMETER	1Ton conventional AC	Compact AC
1	Casing Dimension (WxDxH)	(660 mm x 705 mm x 430 mm)	(485 mm x 550 mm x 550 mm)
2	Coefficient of performance (COP)	3.02	3.25
3	Power input	1050 W	760 W
4	Energy Efficient Ratio (EER)	2.90	2.90
5	Cooling Capacity	3370 W	2204W
6	Refrigerant	R-22	R-134a
7	Additional Features	Inner Groove, Easily Removable Panel, Fresh Air Ventilation, Energy Saver, Auto Swing, Timer, Memory Function, Self-Diagnosis, Auto Defrost	GSM operated, Fresh Air Ventilation, Energy Saver, Auto Swing, Temperature & humidity display
8	Weight	55 Kg	18.5 Kg
9	Estimated Cost	23500 INR	13500 INR

Future Scope:-

Air conditioner plays an important role in maintain the human comfort level in closed chamber. Some time it difficult to use present conventional air conditioner; therefore we develop a portable air conditioner which should be less weight and size. It should be easily carry out. At present, single phase induction motor used to drive the compressor. But it has heavy weight in comparison to brushless DC motor. Further experiment trial will be done on motor to reduce the overall weight and size of Compact air conditioner.

There are some fallowing parameters

1 To provide better cooling in less power usage.
2 Increasing tonnage of air conditioner in cheaper cost.
3 More compact dimension and size so easily portable from one place to another.
4 Rate of Evaporator should be better
5 Refrigerant use is more eco-friendly and least harm the environment
6 Exhaustion of warm air should be very less so that there is no global warming.
7 Updating of equipment and parts as per desire condition
8 New technologies adopting for better use
9 Material used for body should be smart material which reduces the weight of AC
10 Compressor used in future which will compress easily and make working fast
11 Use less power consumption Compressor
12 In future we make AC which easily run by single inverter battery
13 Use of Artificial intelligence in air conditioner for more convenient working.
14 Use of temperature Adjustable system which adjust temperature as per according to human needs.