ANJUMAN-I-ISLAM'S
KALSEKAR TECHNICAL CAMPUS, NEW PANVEL
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☑ SCHOOL OF ENGINEERING & TECHNOLOGY
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DEPARTMENT OF ELECTRICAL ENGINEERING

UTILIZATION OF ELECTRICAL ENGINEERING

MODULE 5: OTHER APPLICATIONS OF ELECTRICAL ENGINEERING

- **Terminology**
- **Refrigeration cycle**
- **Vapour compression type**
- **Vapour absorption type**
- **Electrical circuit of a Refrigerator**
- **Room Air conditioner window type & split type**

Refrigeration: It can be defined as the process of transferring heat from a low temperature region to a high temperature region. In other words it is the process of cooling a substance. This can be achieved only if the heat is removed from that substance.

Principle of refrigeration:

The principle of refrigeration is based on second law of thermodynamics. It states that heat does not flow from a low temperature body to a high temperature body without the help of an external work.

In refrigeration process, since the heat has to be transferred from a low temperature body to a high temperature body some external work has to be done according to the second law of thermodynamics as shown. This external work is done by means of compressor, condenser etc. The machine, which works under this principle and serves the purpose of refrigeration is called a Refrigerator

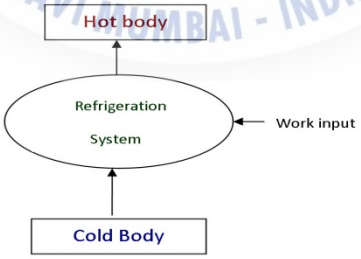

Figure 31.1: Principle of refrigeration system

Terms in refrigeration:

1. Refrigerator: It is a process of moving heat from one location to another in controlled conditions. The work of heat transport is traditionally driven by mechanical work but that can also be done by heat, magnetism or by electricity

2. Refrigerant: It is substance, which is used as a working fluid in refrigerators. The refrigerant has low boiling point, which means that it vaporizes at low temperature and takes away the heat from a substance

3. Capacity of Refrigerator: It is defined as the rate at which heat can be removed from the cold body. Simply it is the rate at which refrigeration can be produced. Its unit is expressed in terms of Ton of Refrigeration. One ton of refrigeration is defined as the quantity of heat removed to freeze one ton of water into ice at 0oC in 24 hours. Its value is 3.5 KW.

4. Refrigeration Effect: It is defined as the ratio of the quantity of heat removed to the time taken. Refrigeration Effect = Heat removed / Time taken

5. Coefficient of Performance (COP): It is defined as the ratio of heat absorbed in a given time (Refrigeration Effect) to the work done

Vapour Compression Refrigeration System:

This type of refrigeration system is the most commonly used system in domestic refrigerators. In VCRS the vapour alternatively undergoes a change of phase from vapor to liquid and vice versa during a cycle.

Construction: Vapour compression refrigeration system has the following components at its basic parts.

1. Compressor: The function of the compressor is to compress the input refrigerant of low pressure and low temperature. As a result the pressure and the temperature of the refrigerant increases. Generally reciprocating compressors are used in a refrigeration system. An external motor is used to drive the compressor.

2. Condenser: The condenser is a coil of tubes, which are made of copper. This is used to condense the refrigerant which is in the form of vapour and convert into liquid.

3. Expansion Valve: This is also called as throttle valve. This valve is used to control the flow rate of refrigerant and also to reduce the pressure of the refrigerant.

4. Evaporator: This is the part in where the cooling takes place. This is kept in the space where cooling is required. It is a coil of tubes made up of copper.

Working Principle: The refrigerant, which is at low pressure and low temperature flows into the compressor. In the compressor the refrigerant is compressed and converted into a high pressure and high temperature refrigerant.

This high pressure and high temperature refrigerant in vapour form then passes through the condenser where it is condensed into high pressure liquid refrigerant. The high pressure liquid refrigerant thus produced passes through the expansion valve.

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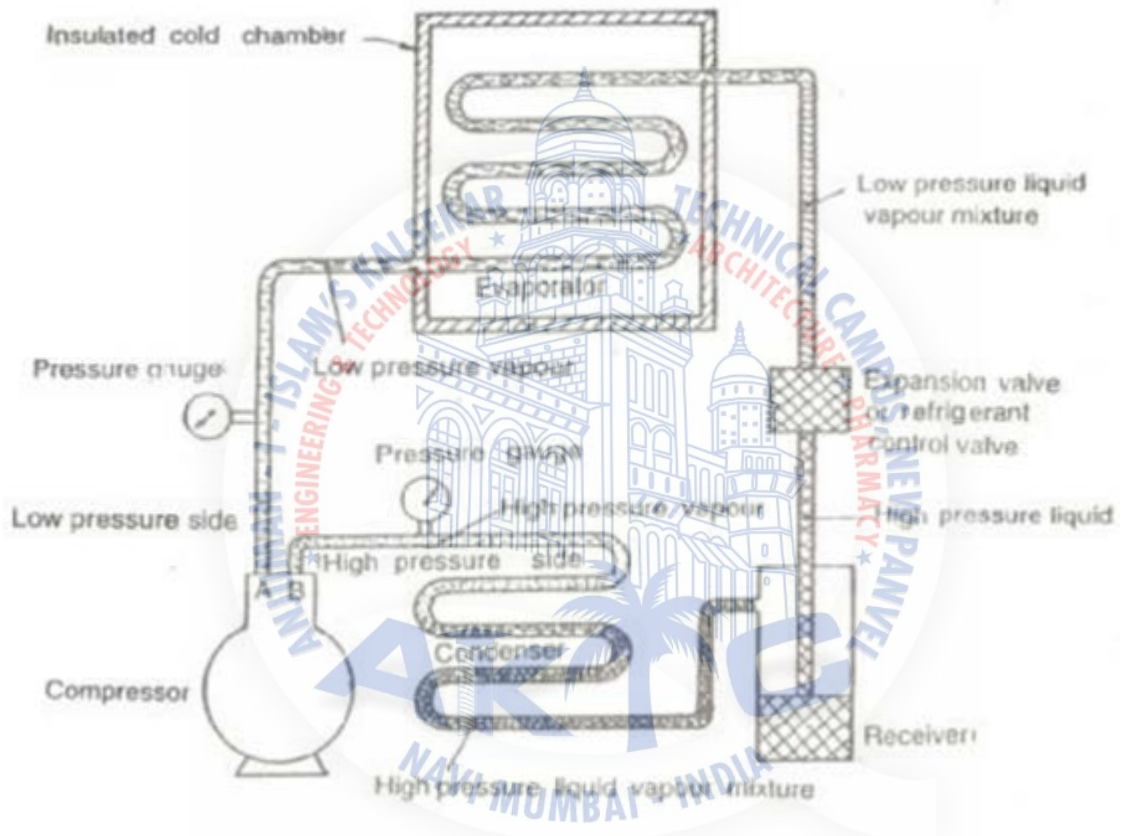
In the expansion valve the pressure and temperature of the refrigerant drops and it partly evaporates. It is the allowed to flow into the evaporator at a controlled rate.

In the evaporator, the partly liquid and vapour refrigerant is mostly evaporated and converted into a low pressure vapour. During this process, the refrigerant absorbs its latent heat of vaporization from the material that is to be cooled. Thus the body is cooled in the evaporator . Then the low pressure vapour refrigerant enters the compressor and the cycle is repeated. Thus a material is cooled in vapour compression system.



Vapour Absorption Refrigeration System:

The compressor in the vapour compression refrigeration system consumes lot of energy. To avoid this, the vapour absorption refrigeration system has been developed. In this system, the compression process of vapour compression cycle is eliminated. Instead of that the three following process are introduced.

Ammonia vapour is absorbed into water . This mixture is pumped into a high pressure cycle This solution is heated to produce ammonia vapour.

Construction: The vapour absorption refrigeration system has the following components.

Generator: The generator receives the strong solution of aqua-ammonia from the absorber and heats it. Because of this heating, the aqua-ammonia solution gets separated into ammonia vapour at high pressure and hot weak ammonia solution which contains mostly water.

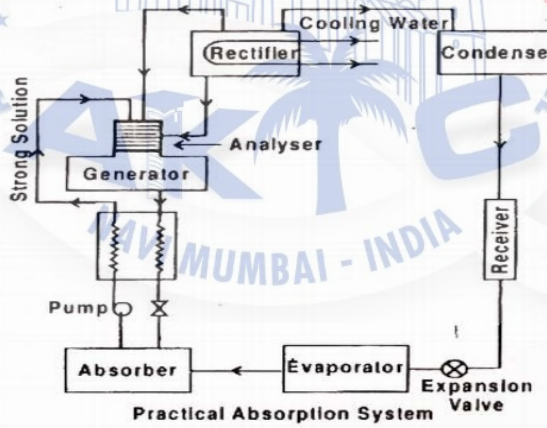
Condenser: The condenser converts the high pressure ammonia vapor received from the generator into high pressure ammonia liquid. This condensation is done by means of circulating cool water.

Expansion valve: This valve is otherwise called the throttling valve since the expansion, which takes place here, is throttling. While passing through this valve, the liquid ammonia gets expanded and gets converted into low pressure and low temperature ammonia.

Evaporator: The evaporator is otherwise known as cold chamber. Here the refrigerant absorbs the heat from the material which is to be cooled and gets evaporated. It has many coils made of copper.

Absorber: The absorber receives the low pressure ammonia vapour from the evaporator and the weak ammonia solution from the generator and mixes them well to form a strong solution of aqua-ammonia.

Practical vapour absorption system



Practical Absorption System

Working Principle:

The working fluid in vapour absorption refrigeration system is normally ammonia. The ammonia vapour and water are mixed to form a strong solution of aqua-ammonia in the absorber. This aqua-ammonia solution is then pumped into the generator. In the generator, this solution is heated. Because of heating, ammonia gets evaporated at high pressure and leaves behind the weak ammonia solution, which mostly contains water.

The high pressure ammonia vapour produced by the generator is condensed in the condenser and it becomes ammonia liquid, which is at high pressure. This high pressure liquid ammonia is allowed to pass through the expansion valve or throttling valve where it expands and becomes a low pressure and low temperature ammonia which mostly contains liquid ammonia and a little vapor ammonia. Ammonia at low pressure and low temperature then passes through the evaporator where it absorbs the heat from the material which is to be cooled and gets evaporated. The evaporator is where the real cooling takes place. Because of the heat absorbed by ammonia, it gets evaporated and becomes low pressure ammonia vapour. The low pressure ammonia vapour is then sent into the absorber and the cycle is repeated.

Ammonia at low pressure and low temperature then passes through the evaporator where it absorbs the heat from the material which is to be cooled and gets evaporated. The evaporator is where the real cooling takes place. Because of the heat absorbed by ammonia, it gets evaporated and becomes low pressure ammonia vapor. The low pressure ammonia vapor is then sent into the absorber and the cycle is repeated.

COMPARISON OF VAPOUR COMPRESSION & VAPOUR ABSORPTION SYSTEM

Sr No	VAPOUR COMPRESSION SYSTEM	Sr No	VAPOUR ABSORPTION SYSTEM
1	It is more noise and wear and tear because of more moving parts of the compressor	1	The system is comparatively quieter. Since the moving part is only aqua pump
2	Mechanical energy is utilized by means of compressor	2	Heat energy is utilized
3	Refilling of refrigerant is easy	3	Refilling of refrigerant is difficult
4	During partial loading conditions the performance is poor	4	The performance is not affected even at the partial loading
5	The liquid refrigerant accumulated in the cylinder may damage the cylinder. So preventive measures are needed.	5	Liquid refrigerants do not affect the performance of the system. They do not produce any bad effect
6	Electric power is required to drive the system	6	Waste of exhaust stem may be used no need of electric power
7	Capacity of the system drops rapidly With the lowered evaporator pressure	7	Capacity of the system decreases with the lowered evapourative pressure, by increasing the steam pressure in the generator

Applications of Refrigeration:

- In manufacturing ice
- For Preserving perishable food materials

• For Cooling water

• For preserving of blood, tissues and medicines

Electrical Circuit of a Refrigerator

Components

Lamp: The arrangement is made in such a way that lamp remains "off" as the door is closed and becomes "on" when door is opened

Thermostat switch: A thermostat switch maintains a requisite temperature in the refrigerator

Thermal overload release: This component is a protective device for compressor motor unit. It operates when temperature of the compressor rises beyond a certain level or excessive current flows in the motor under such conditions the bimetallic strips disconnect the supply to the motor

Starting relay: A starting relay starts the motor by putting auxiliary winding of split phase induction motor across the supply

Electric motor: Electric motor used in single phase induction motor. It is a fractional horse power induction motor whose size depends upon the capacity of the refrigerator

Working

When electric supply is given to the refrigerator, current passes through the thermostat switch, thermal overload release, coil of starting relay and main winding of the motor.

When the motor is in rest it draws a heavy current & when this heavy current flows through the coil of the starting relay the coil gets energised and it pulls up the plunger, short circuiting the contacts and putting auxiliary winding also in the circuit

Now since both main winding & auxiliary winding are energised motor starts running. When the motor gains normal speed, the current drawn by the main winding of motor becomes normal

At normal current plunger in the coil of starting relay cannot remain pulled and it is released down, opening the contacts the auxiliary winding gets out of the circuit. The main function of starting relay is to put auxiliary winding in the circuit at the time of starting the motor and to disconnect it when the motor gains normal speed

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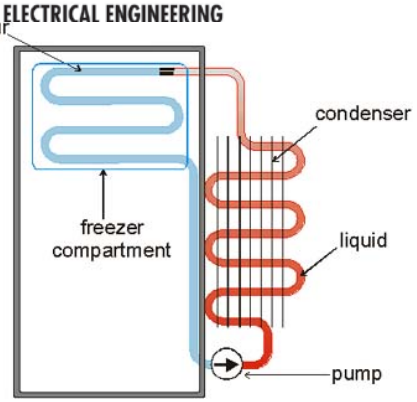


Air Conditioning: It is the process of controlling and maintaining the properties of air like temperature, humidity, purity, direction of flow etc in a closed space. One can have the desired condition around him using air conditioning.

Window type air conditioner working

The refrigerant vapour leaving the compressor is at high pressure and temperature. It then passes through the condenser. Outside air is drawn in by the fan and it cools the refrigerant in the condenser, the refrigerant then becomes liquid.

The high pressure, low temperature liquid refrigerant enters the expansion valve. The pressure and temperature of the refrigerant falls when it leaves the valve.

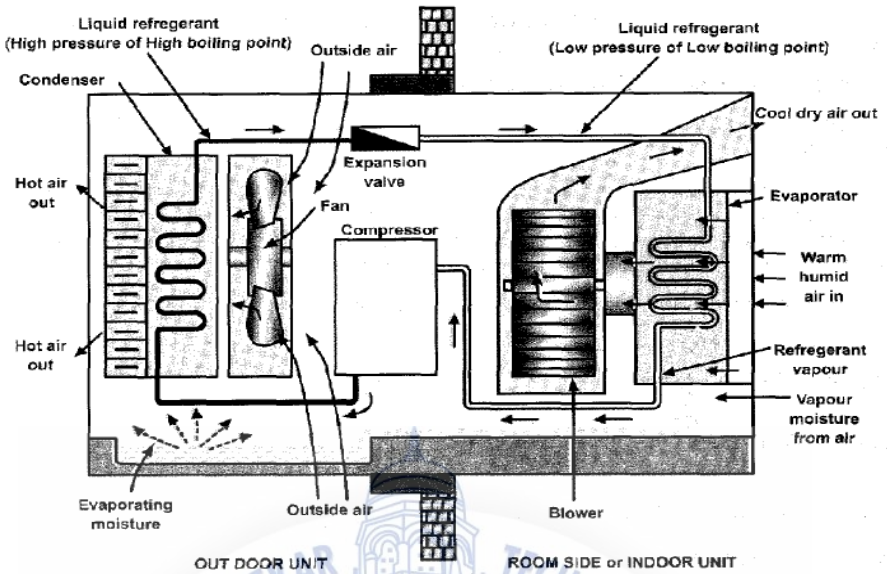
The cold refrigerant from the valve passes through the evaporator (the evaporator side of the air conditioner faces the room to be cooled). The warm air from the room is drawn in by blower.

The evaporator cools this air and the liquid inside the evaporator tube gets vaporized by absorbing the heat from the warm air. The cool air is again sent to the room through the opening at the top of the air conditioning unit.

The liquid and vapour refrigerant from the evaporator passes to the compressor and is compressed to high-pressure, high temperature liquid. The operation hereafter is carried out in cycle as the same manner as explained.

The amount of air circulated into the room can be controlled by the dampers provided. When air flows over the cooling coil or the evaporator coil, the moisture in the air gets condensed and they are made to drip into the trays provided below the coils. This water evaporates to some extend and thus helps in cooling the compressor and condenser.

For every cycle, the temperature of the air keeps on reducing. The unit automatically stops with the help of thermostat and control panel, when the required temperature is reached inside the room.



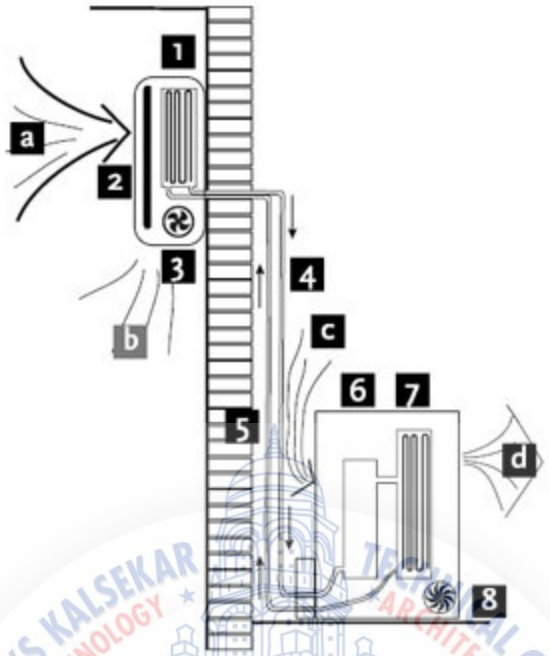
Split Air Conditioner:

A Streamlined and light-weight air handler is mounted on the inside wall. Refrigerant and condensate lines run through a small hole in the wall to the outside unit. Initial power is to the outside unit and then relayed to the air handler. Extremely quiet as the compressor and condenser coil are outside. Full electronic and remote control.

The compressor (6) in the exterior unit compresses the refrigerant into a high-temperature, high-pressure gas. When this gas flows along the cooling fins of the condenser (7), heat is exuded and the gas is led to the evaporator (1) in the interior unit.

The liquid expands into a gas at a low temperature and low pressure. This gas absorbs the warmth of the air in the room, the cooled air is blown back into the room and the heat is led to the compressor along with the gas.

A fan (3) draws the air (a) over the filter (2) and blows the cooled air (b) back into the room. A fan (8) draws air over the condenser and blows warm air (d) away. As with cooling, the moisture in the air condenses on the cold evaporator at room temperature.



1. Evaporator
2. Filter
3. Fan
4. Gas line
5. Liquid line
6. Compressor
7. Condenser
8. Fan