General and special refrigeration tools and their function

Objectives: At the end of this lesson you shall be able to
- **explain about common basic refrigeration tools and their function**
- **explain about common instruments & equipments.**

Introduction

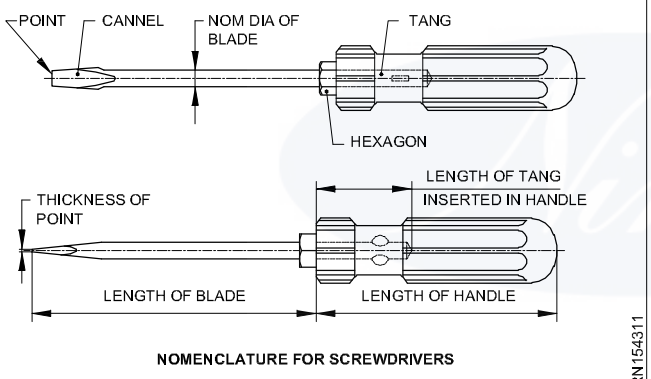
Diagonal cutting plier: It is used for cutting small diameter wires and cables especially when they are close to terminals. It is also used to remove the insulation from cables and cords. It can be used for splitting and removing catter pins.

Screwdriver: Screw driver is used to tighten or loosen screws. Screwdrives are specified in size by the length of the blade and the width of the tip.(Fig 1)

A very small screw driver is 45mm long and 3mm in diameter.

A larger screwdriver is 300mm long and 10mm in diameter.

Fig 1



NOMENCLATURE FOR SCREWDRIVERS

Combination pliers

Fig 1 shows a COMBINATION PLIERS and its application. A number of operations can be performed with these pliers.

The FLAT GRIP can be used to grip and hold parts and components and to twist wires.

Many combination pliers also have a PIPE GRIP which is used to grip and hold cylindrical objects.

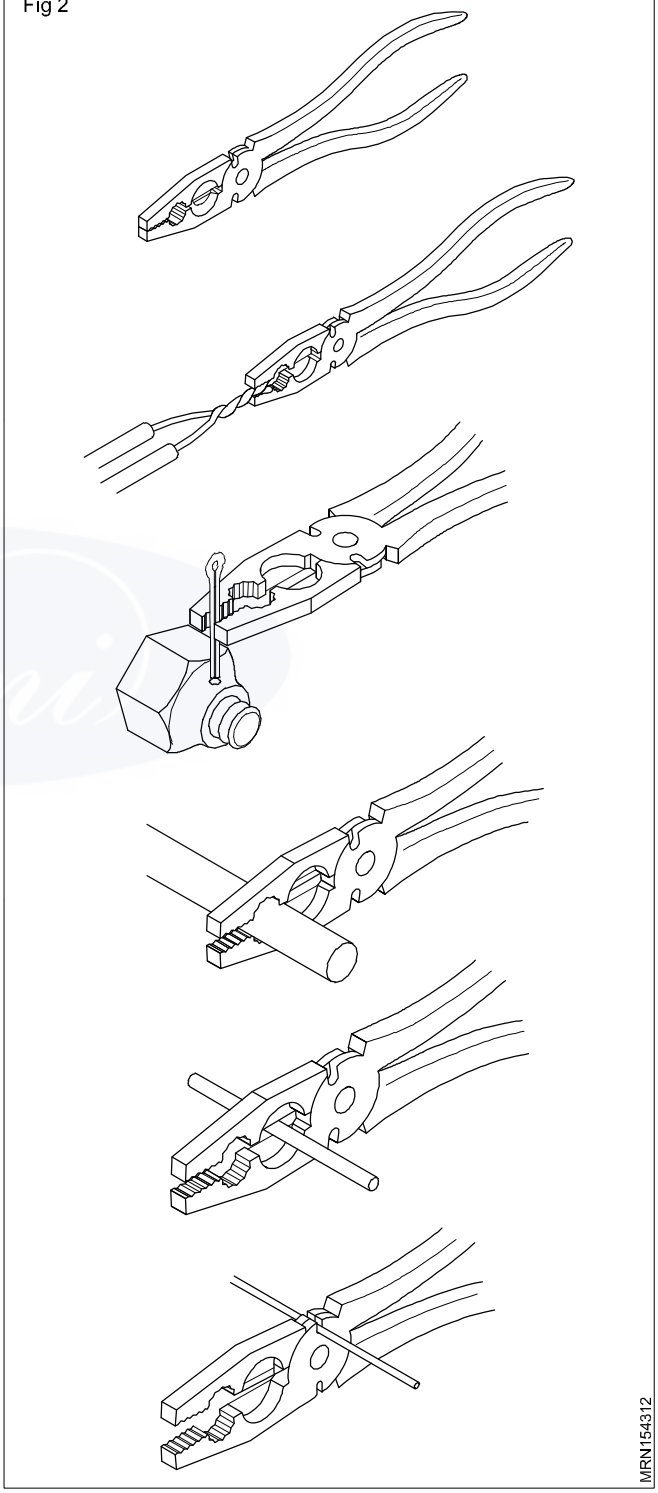
They also have a pair of SIDE CUTTERS which are used to cut small diameter wires and cables.

A pair of JOINT CUTTERS are provided for shearing off steel wires.

Combination pliers are available in the following overall lengths:

140, 160, 190, 210 and 250 mm.

Fig 2



Refer Exercise No 1.1.01 for other tools, instruments and equipments

Types of refrigeration systems

Objectives: At the end of this lesson you shall be able to
- **explain function of refrigeration**
- **explain types of refrigeratin system**
- **explain the construction working at refrigeration system.**

Refrigeration is a process of reducing of the temperature and preseve the perishable food stuff and medicines for future use. The different refrigeration system are given below.

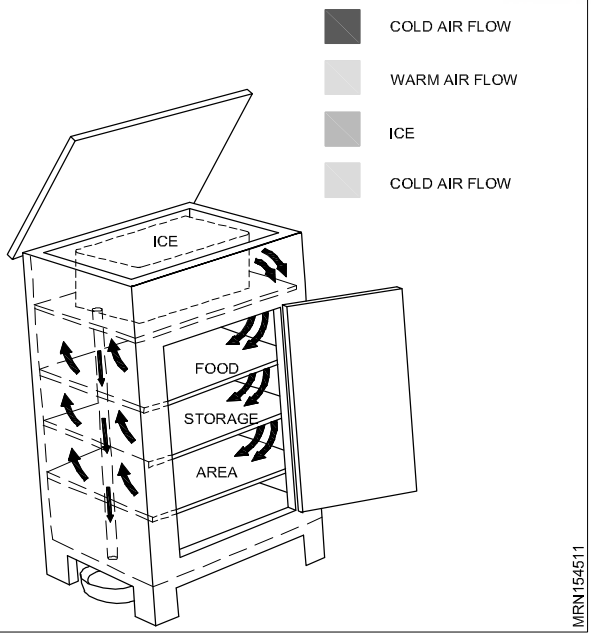
- Ice refrigeration
- Dry ice refrigeration
- Water vapour system
- Liquid gas refrigeration system
- Vapour absorbtion system
- Vapour compression system

Ice refrigeration system

It is one of the earliest method for producing cold. Now a days this system used for preservation of fish and many other application for cooling. The main disadvantage of this is it cannot maintained below 0^0C (centrigrade) and refill the ice after melting.

A ice refrigeration system shown in (Fig 1) it is an insulated cabinet equipped with a tray for hodling ice blocks. Foods are located below inside at the cabinet below the ice tray. The ice absorb heat from food stuff and food substance is to be cooled.

Fig 1

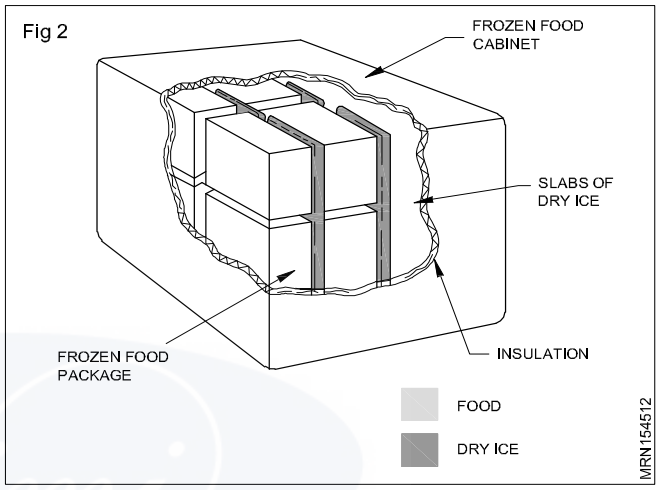


When it is necessary to use ice for cooling temperature below 32^0F, ice and salt mixture may be used.

Dry ice refrigeration (Fig 2)

Solid carbon dioxide is known as dry ice. It directly change solid to vapour stack by absorbing heating and maintained a temperature at -78^0C. This process is known as sublimation. The dry ice is pressed into various sizes and shapes in to food container. Dry ice is usually stored in heavily insulated cabinets. Never handle it with bare hands. It will cause instent freeze burns. Always wear heavy gloves.

Fig 2



Liquid gas refrigeration system

In this system the non poisionous liquid (Nitrogen) is used to cool the space. This system is called as expandable refrigerant refrigeration system also or chemical refrigeration.

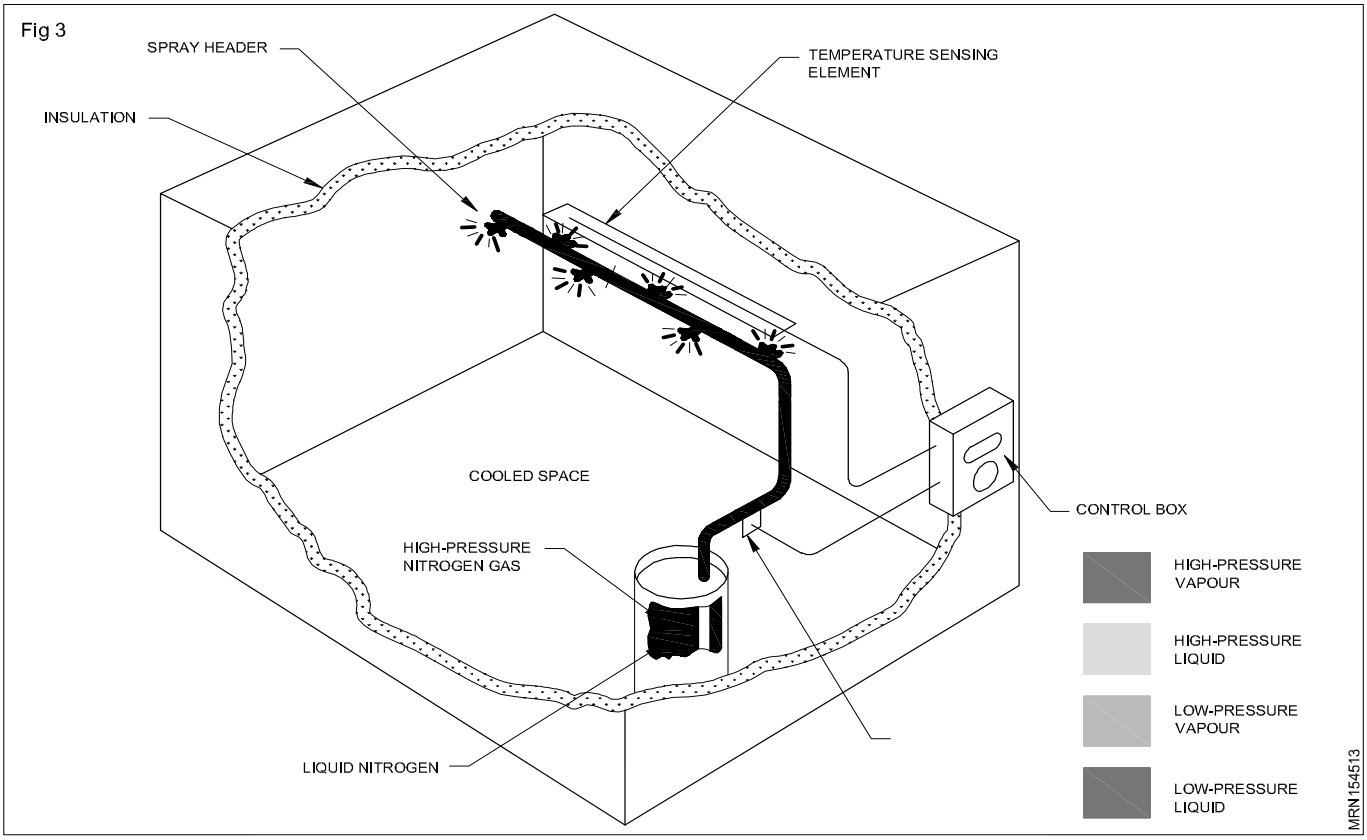
It is used on trucks and other vehicles in the transportation and storage of refrigerated or frozen foods. It has a heavily insulated space,which is cooled by either being surrounded by tubes carrying evaporating liquid nitrogen or by spraying liquid nitrogen directly into the space to be cooled. The liquid nitrogen (see fig) is supplied from a cylinder inside the refrigerated space is kept under pressure (200 psi).

An automatic pressure relief valve will open as a safety measure and allows the nitrogen vapour to escape, while the pressure exceed the relief valve setting.

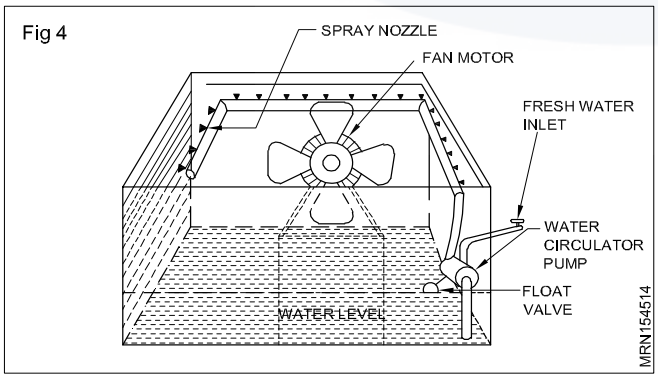
A temperature servicing element control box and liquid controls valve, control the flow of liquid nitrogen from the nozzles. They maintain the desired temperature inside the refrigerted space.

Water vapour system

It is one of the method to produce cooling. Generally it is used for air cooling in high temperature areas when some water will evaporate it absorbs heat and space is to be cooled. In construction it has a water tank, float valve, water pump, fan khass khass pad and oscillating motor. The water tank is located in the bottom and water level is maintained by a float valve. The water is circulated by a



water circulating pump. The pad are fitted on the three sides at the system when motor on the water pump sucks water from the tank and sprayed over the pad.In this time the fan draws warm air from through pads and water absorbs heat from air and air is cooled by evaporation process. The cold air is circulated in to the room. They call this system as air cooler or desert cooler.(Fig 4)



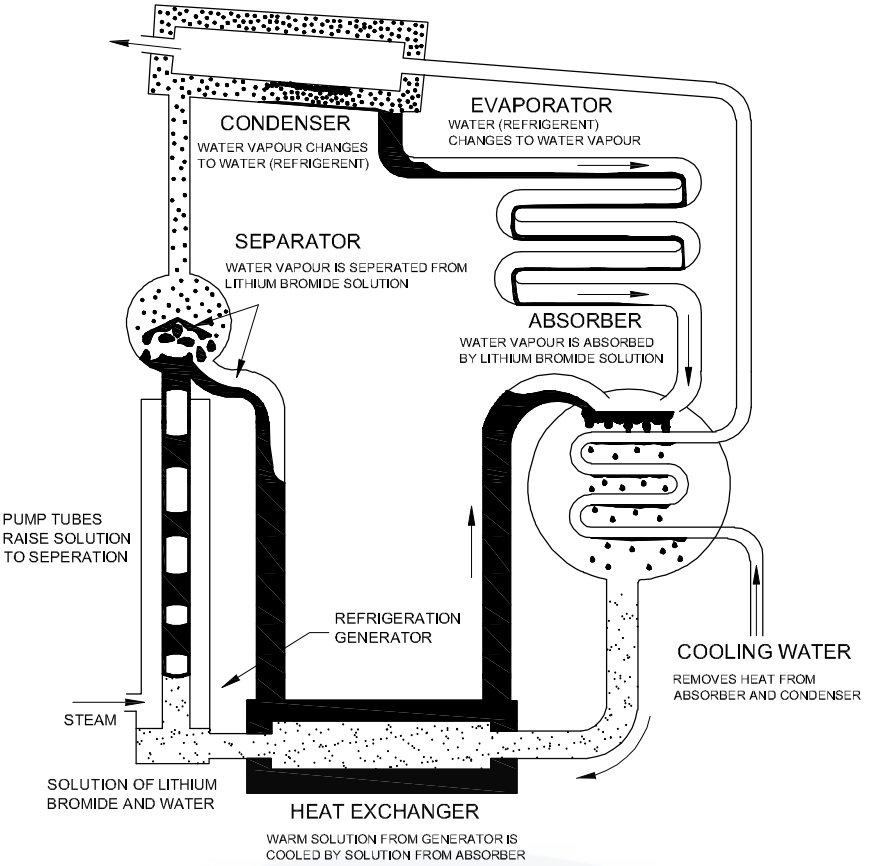
Vapour absorption system:

The absorption system is different from the compression system. It uses heat energy instead of mechanical to make a change in the conditions necessary to complete a refrigeration cycle (Fig 5)

The vapour absorption refrigeration is a heat operated system. It is similar to the mechanical vapour compression system. In both the systems we have the evporator and condenser. In the absorption system the compressor is replaced by the combination of absorber and generator. A solution known as the absorbent, and the generator by a pump (solution pump). The absorbant in the absorber draws the refrigerant vapour formed in the evaporator maintaining a low pressure in the evaporator to enable the refrigerant to evaporate at low temperature. Inthe generator the absorbent is heated, there by releasing the refrigerant vapour (absorbed in the absorber) as a high pressure vapour, to be condensed in the condenser. The absorbent solution carries the refrigerant vapour from the low side (evaporator absorber) to the high side (generator condenser). The liquified refrigerant flows from the condensor to the evaporator because of the pressure difference between the two vessels, & refrigerant circulate through the system.

In the absorption system the refrigeratnt vapour from the evaorator is absorbed and condensed in the absorbent solution in the absorber from here the solution with the dissolved refrigerant is pumped upto the high side (generator condenser)The refrigerant vapour is released from the absorbent solution by heating it in the generator. The energy input for this refrigeration cycle is the heat energy in the form of steam or hot water, instead of electrical (motor) or mechanical energy employed in the mechnical vapour compression system.The evaporator and absorbs are inter connected so the refrigerant vapour formed in the evaporator is absorbed by the absorbent inthe absorber to maintaining the refrigerant vapour pressure in one evaporator at the low level required for continous vapourization of liquid refrigerant to obtain refrigeration. To recovere the refrigerant from the absorbent it is pumped fromthe absorber to the generator where it is heated using steam or hot water. In a domestic refrigerator of water ammonia system a kerosene flame or electric heater is used for the heating on getting heated the absorbent releases the refrigerant vapour as a high temperature /pressure vapour. It passes to the comparatively cooler condenser where it is condensed. The liquid refrigerant then passes on to the evaporator so completing the refrigerant cycle. The absorbent flows back from the generator to the absorber.

Fig 5



Heat is generated when the refrigerant is absorbed by the absorbent known as the heat of absorption or heat of dilution. Further the refrigerant vapour condenses in one absorbent solution and for this the latent heat of vapourization of the refrigerant vapour has to be removed. The absorber also needs cooling and for this the cooling medium (air or water) used for the condenser is first passed through the absorber and the condenser.

Ammonia - Absorption machines

This system employs ammonia as the refrigerant and water the absorbent.

Lithium bromide absorption system

In this system lithium bromide salt solution is employed as the absorbent and water as the refrigerant.

Three fluid absorption system

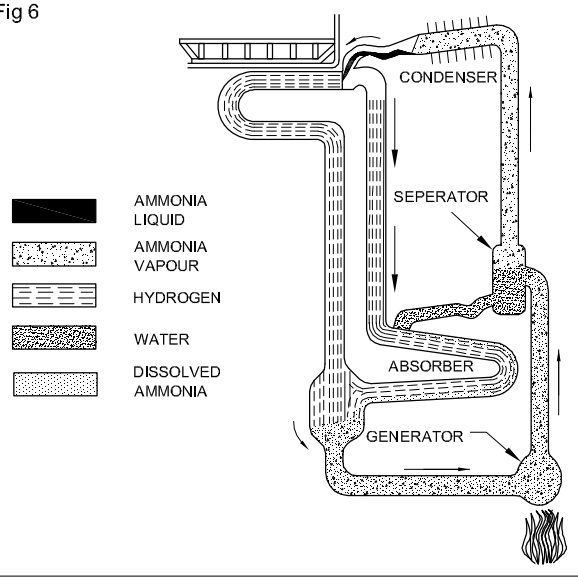
In three fluid absorpton system a lighter gas compared to the refrigerant vapour is introduced into the sytem. The pumping system is eliminated. As such a complete leak-proof silent system is achieved.It consists of a gererator where heat transfer with weak solution is bubble form moves up to the separtor. The weak solution then returns to the absorber through a liquid seal, while the vapour condenses the passes into the evaporator through another liquid seal. The liquid seal prevents the light gas from escaping to the condenser side. Hence the condenser pressure corresponds to ammonia condensing temperature.

In the evaporator a light gas is charged such that the partial pressure of ammonia should give the desired evaporator temperature. As ammonia vaporizes inthe evaporator it gets absorbed on the otherhand the light gas gets heated up by the weak solution from the separator. The warm light gas has tendency to move up and then come down with the ammonia vapour in orde rto have steady flow system. The absorber then supplies the strong solution to the generator completing the cycle.(Fig 6).

The actual three fluid system which was developed uses hydrogen as the lighter gas with ammonia water combination with molecular weight of ammonia as 17(Fig 6)

This combination has worked very satisfactorily and as such commercial domestic refrigerators were manufactured ona mass scale basis.

Fig 6



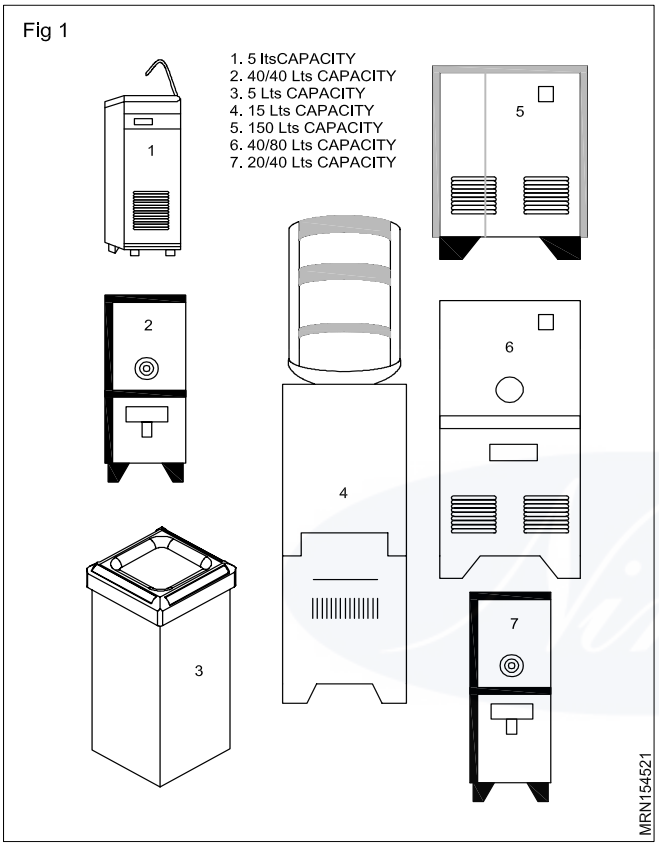
Application of vapour compressin system

Objectives: At the end of this lesson you shall be able to

- **explain the devices of vapour compression system.**

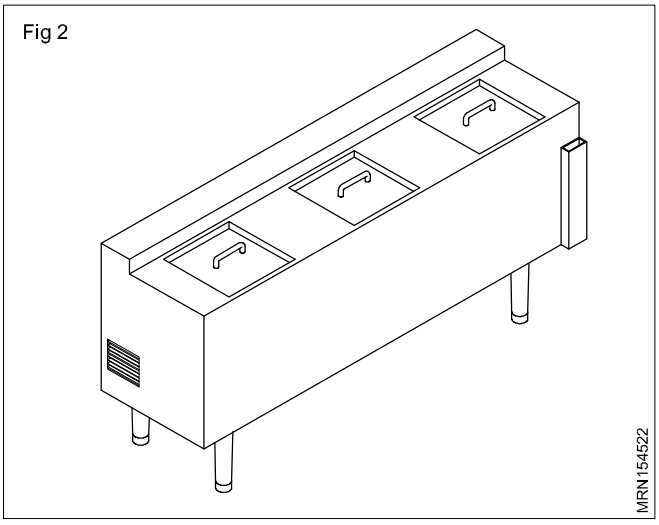
Water Cooler: Water cooler becomes an important aspect to quench thirst of human/people at various centre's such as restaurants, theatres, offices, commercial complex etc (Fig 1).

Fig 1



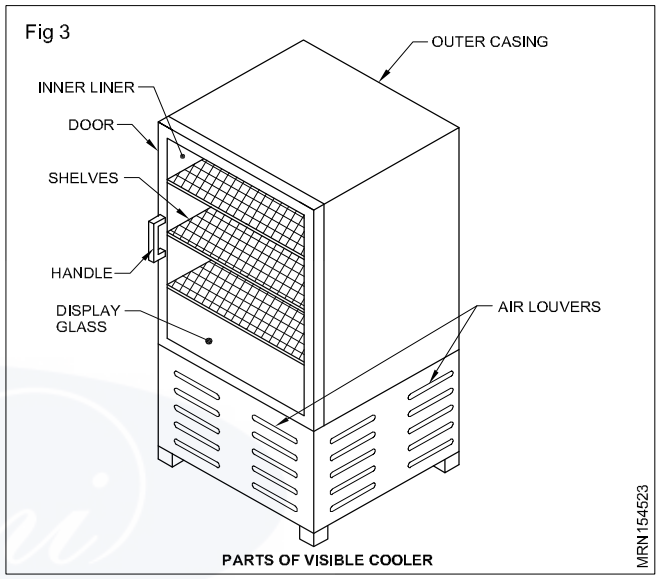
Bottle cooler: The bottle coolers are used in petty shops offices and commercial establishments. Direct expansion type bottle coolers are one in which the cooling coil is wound around the storage tank. The winding of coil in other type of bottle coolers are inside the storage tank.(Fig 2)

Fig 2



Visible cooler : Visible cooler is a type of refrigerated cabinet that displays merchandise as well as cools it. It is commonly used to keep cool the foold products such as beverages, bakeries, chocolates, milk etc.Visible coolers are widely used in commercial establishments. These coolers are maintaining the temperature range between 0 to 10^0C inside (Fig 3)

Fig 3

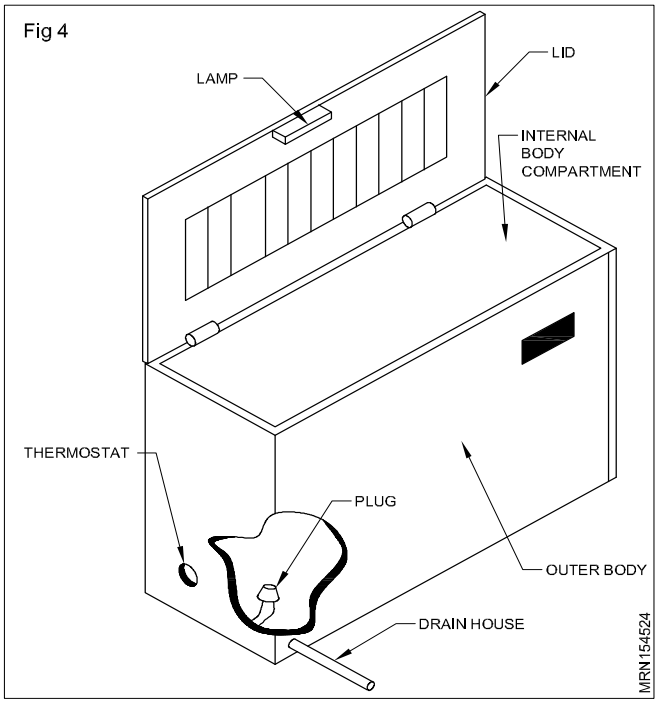


PARTS OF VISIBLE COOLER

Deep freezer

Deep freezer are the refrigerated cabinets which are used to store the perishable food products (meat products dairy products etc) at the requires temperature levels (-10^0 C to 30^0C) (Fig 4)

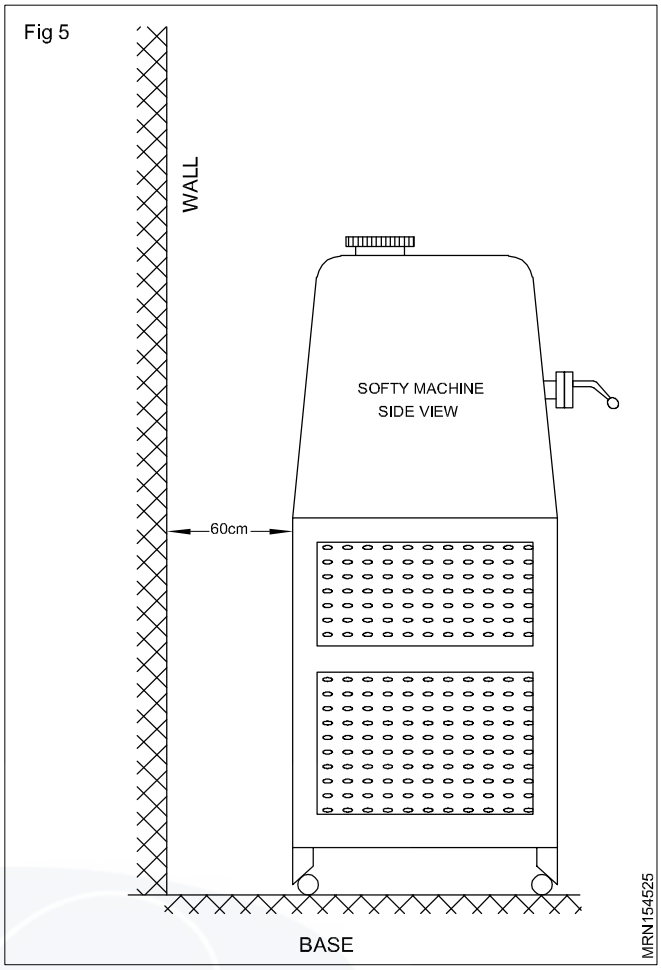
Fig 4



Softy machine

Ice cream mix containing milk cream, syrup and fruit or other flavouring ingredients. The mix is poured in the master tank and the churner is put on along with the refrigeration system and after about 15 minutes the outlet valve can be opened and check the sample. If found semi solid then the cones can be filled and served or it could be stored in a freezer.(Fig 5)

Fig 5



Study of vapour compression system

Objectives: At the end of this lesson you shall be able to

- **explain vapour compression system.**

Refrigeration: Refrigeration is the process of heat removal from a substance or from a space resulting in lower temperature below that of the surroundings.

Refrigeration cycle works in four phases.

- Compression
- Condensation
- Expansion
- Evaporation

Refrigeration cycle:

When the compressor starts to work, compressor suck the low temperature vapour from evaporator by suction line. Compressor compresses low pressure, low temperature vapour and it turns to high pressure and high temperature vapour. It delivers to condenser.

There it cooled by air or water. The vapour turns to liquid state. Expansion device meters out the required amount of refrigerant to evaporator. At this time due to expansion the refrigerant turn into low pressure low temperature liquid and vapour. The refrigerant absorb the heat from the space/substance to be cooled, vapourize and turns to low pressure low temperature vapour. The same refrigerant returns to compressor suction for compression.

It is called refrigeration cycle.

Sub cooling

Sub cool the refrigerant liquid before it enters the expansion device sub cooling the liquid in liquid -suction heat exchanger, the temperature of the liquid at the inlet of the expansion valve can be brought down.

Super heating

Super heating is the heating at vapour above its vapourizing temperature. It takes place at the last coil at the evaporation.

Low side & high side of vapour compression cycle.

Accordingly to pressure difference a v.c. cycle have two sides for easy evaporation and condensation. The high side have half at compressor, discharging line, condenser liquid receiver, drier and half at expansion valve. The low side having half of expansion valve. evaporator accumulator, suction lines and half of compressor (refer fig 1 of exercise 1.4.05 typical compressors refrigeration system).

Fundamentals of Refrigeration

Objectives: At the end of this lesson you shall be able to
- **study the refrigeration**
- **describe about the pressure and measurement.**

Refrigeration : Refrigeration may defined as a process of heat removal from a substance or from a space resultng in lower temperature below that of the surroundings.

The refrigeration system works on vapour compression cycle.

The cycle works in four phases.

- Compression
- Condensation
- Expansion
- Evaporation

The carrier substances used to carry the heat is called a refrigerant.

Refrigeration is accomplished by various methods such as the vapour compression system, absorbtion system, steam jet refrigeration cycle etc.

Pressure measurment

Objectives: At the end of this lesson you shall be able to
- **understand about the pressure and measurement.**

Pressure is the force exerted per unit area. Whenever a force is evenly distributed over an area the pressure at any point on the contact surface is the same and can be calculated by dividing the force by the total area over which the force is applied. Pressure is expressed in units, such as pounds per square inch (psi)pounds per square foot (p.s.f)grams per square centimeter, kilograms per square centimenter (kg/cm^2) kilograms per square metre(kg/m^2) etc.

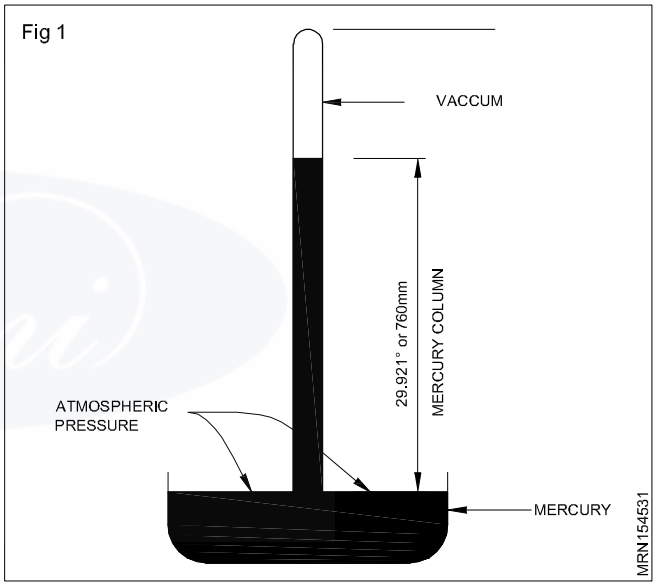
We live at the bottom of a sea of air mixed with water vapour, some fifty miles deep. Both air and water vapour have weight. A column of this air one squar metre (one square inch) in cross section extending upwards to about 80km (50 miles) weighs 1.033 kg (14.696 lbs). So every square cm (square in) of land, sea, person or article bears a weight of 1.033 kg(14.7lbs) so we say that the atmospheric pressure at the sea level is 1.033 kg/cm^2.[14.7lbs per square inch (psi)].

As we go up a mountain obviously the weight of the air exerted becomes less on a mountain using the same argument as we go down below the sea level. Say inside a mine, the atmospheric pressure increases. Roughly for every 300 metres (thousand feet) change i n altitude from sea level, the atmospheric pressure varies by about 0.035 kg/cm^2(0.5psi).

Atmospheric pressure is measured with the help of a barometer (Fig 1).

A glass tube about 36" long and closed at one end is filled with mercury. The open end of the tube is covered with a finger and then inverted into an open dish containing mercury. When the finger is removed from the tube end, the mercury column in the tube falls down to a certain height leaving an almost perfect vacuum in the closed end of the tube. The pressure exerted by atmospheric air on the surface of the mercury in the dish causes the column

Fig 1



of mercury in the tube to stand. Therefore, the height of the mercury column in the barometer gives a measure of the atmospheric pressure. At sea level the mercury column will be 76 cm (29.921") The weight of 76cc (29.92 cu.in) of mercury is 1.033 kg(14.696 lb). Thus the atmospheric pressure at sea level can pushup a column of mercury in a vacuum tube to a height of 29.921" or 760mm. so we say that the atmospheric pressure at sea level is 1.033 kg/cm2(14.7 psi) or 760mm (29.921") of mercury, written as 760 mm or 29.921" Hg-'Hg' stands for the latin name hydrargyrum for mercury. Thus 1 psi pressure equals 29.921/14.696/14.696=2.036" (51.7mm)of the mercury column.

Thermo dynamic processes

When a substance, in any of the physical statesolid, liquied or gas, is heated, it expands, i.e. its volume increases and thus its density decreases. Similarly when a substance is cooled, it contracts or its volume decreases. Water, however, behaves differently between the temperatures 0^0C is heated, instead of expanding, it contracts. This contraction continues until thetemperature of water reaches 4^0C(39.2^0F). Thereafter, further heating will result in expansion. Similarly, water at 5^0C when cooled contracts, but on attaining 4^0C(39.2^0F), any further cooling will make the water expand and not contract until the temperature touches 0^0C(32^0F), solidification (formation of ice) occurs accompanied by further expansion, reducing the density of ice to a level below that of water.

As the temperature of water on the surface in a lake or ocean reaches 4^0C, it becomes denser, and hence drops down , pushing the warm water from below. This process goes on till the whole mass of the water is at 4^0C. When the surface temperature goes below 4^0C, the surface layer becomes lighter because of expansion and thus does not go below and the top layers gradually freeze as the temperature falls to 0^0C. Thus water in a lake or ocean freezes at the surface while the water below remains at 4^0C. This property of water enables the aquatic animals to live comfortably even in the severest of winter.

The property of water enabling it to expand on solidification creats a tremendous expansive force, sufficient to burst water pipes in winter and in refrigeration water chillers.

Like solids and liquids, gases also expand on heating. However, there is a difference in the case of gas, because of its pressure. In the case of gas, there are three variables: (1) pressure, (2)volume and (3) temperature.

Before proceeding further on the properties of gas, it is necessary to understand the difference between gas and vapour. There is a certain temperature for every liquid/gas which is called its critical temperature any amount of increase in pressure cannot liquefy it. When the temperature is below its critical point, the gas can be liquefied without lowering its temperature by merely increasing the pressure. Vapour is defined as that which can be liquefied by only increasing its pressure, while to liquefy gas, not oly an increase in its pressure but also a lowering of its temperature is requied. For example, alcohol, petrol, refrigerants etc.are vapours hydrogen oxygen etc, are gases. Thus vapour behaves as gas above its critical temperature, and gas behaves as vapour below its critical temperature. In the following pages, the gas laws are described which a refrigration mechanic should know. However, it should be understood that in mechanical refrigeration our concern is with vapour and not gases, as they are close to the saturation curve.

BOYLES LAW

This law gives us the relation between pressure (P) and volume (V) when temperature (T) is kept constant. The law states that at constant temperature pressure varies inversely with the volume of the gas. In other words, if volume is increased two times. pressure comes down by half. This means that

Pressure x Volume (P x V) = constant

where, P : Absolute pressure

T : Absolute temperature

CHARLES LAW

1 This gives the relation between volume and temperature, with the pressure kept constant. The law states that at constant pressure, volume varies as the temperature of the gas, i.e.,

$$\frac{V}{T} = constant$$

2 Pressure varies as temperature if the volume of the gas is kept constant, i.e.,

$$\frac{P}{T} = constant$$

Combining these three laws, we have the general gas law, giving the equation,

$$\frac{P\,V}{T} = constant$$

where , P : Absolute pressure

T : Absolute temperature

SPECIFIC HEAT OF GASES

The quantity of heat required to raise the temperature of unit mass of a gas through 1^0, with the volume of gas kept constant, is known as the 'specific heat at constant volume'. Again the heat required to raise the temperature of unit mass of a gas by 1^0 with the pressure remaining constant is called the 'specific heat at constant pressure'.

A gas undergoes a process when it passes from some initial condition to some final condition. These changes can occur inmany ways and two are of interest to us, namely isothermal and adiabatic.

When during the process, there is no change in the temperature of gas, it is called an iso-thermal process.

Science related to refrigeration

Objectives: At the end of this lesson you shall be able to

- **describe about work, power, energy,force, heat, temperature and pressure.**

Work

Work (W) is a force (F) multiplied by the distance (D) through which it travels.

The unit of work is called the joule (J) The joule is the amount of work done by a force of one newton moving its point at application a distance of one metre.