UNIT 12 BUILDING FACILITIES-II

Structure

12.1 INTRODUCTION

An unlimited supply of water on tap is assumed by most of us to be a basic service and, apart from exceptional circumstances such as drought, we barely give a thought to its source and distribution system. Cast iron pipes, buried deep below the surface take water from the reservoirs through the municipality authorities are very common in India. A communication pipe links the main to the boundary of each building and it is at this point the responsibility of the building owner for own water supply begins. Being an integral part of our life: to ensure source of water and its distribution by using up-feeding and down-feeding techniques become our responsibility as a facility manager.

This unit highlights various plumbing and sanitary fittings and fixtures, potable water delivery (distribution system) , and heating and cooling (HVAC) system.

12.2 PLUMBING TERMINOLOGY

Plumbing: Plumbing is derived from the Latin word for lead, plum-bum, because lead pipes were the first practical pipes used during the Roman era.Any system that transports fluids for a variety of purposes is considered plumbing. To transport fluids, plumbing uses pipes, valves, plumbing fittings, tanks, and other equipment.

Air Gap: A device mounted at the back of certain plumbing fixtures allowing discharge water to move freely into a drain pipe, but preventing contaminated water from back siphoning.

Air Lock: The blockage of liquid flow of liquid due to an air bubble in the line.

Anti-Siphon: A device helping to prevent back-flow, for example on sprinklers, sump pumps; Prevents water from reversing back into the feed supply.

Back Flow: When water travels from one system back into any part of the main distribution system; generally caused by siphoning.

Back Flow Preventer: A device used to prevent backflow into a potable water supply.

Back Pressure: Pressure that resists the flow of fluid in a pipe system.

Back Siphoning: Negative pressure that causes backflow conditions.

Backup Sump Pump: A secondary sump pump, usually powered water pressure or battery power.

Bernoulli's Law: The principle that a stream of liquid or gas gives off less sideways pressure while it is in motion than while it is at rest. Consequently, fluids appear to be drawn into a stream, but in reality are pushed in by the higher outside pressure.

Braided Tubing:- Flexible pressure tubing encased in braided threads of steel. The braiding protects the tube from damage due. They are often used in water supply lines for fixtures like toilets, sinks, or water heaters

Bushing:-A pipe fitting that is used to join different sized pipes.

Cast Iron:- Metal made from casting on moulds, covered with a porcelain enamel coating. Used to make fixtures like sinks or tubs.

Centrifugal Pump:-A pump that transports water via centrifugal force created by the rapid spin of an impeller, which forces the water through a discharge outlet.

Check Valve:- A device installed in a pipe system that allows water to flow in only one direction used to prevent backflow.

Cock:- A faucet or valve used to stop or regulate liquid flow.

Compression Fitting:- A type of tubing or pipe connection, in which a nut and sleeve are placed over a copper or plastic tube, compressing tightly around the tube as the nut is tightened, which creates a positive grip and seal without soldering or gluing. Also refers to a flexible connector with a nut and gasket that attaches to a SAE standard compression thread, without using a sleeve or ferrule.

Compression Valve:- A type of valve used for water faucets that activates by raising or lowering a horizontal disk by a threaded stem. Compression valves are used in compression fittings.

Corrosive Water:- Low pH water that has the ability to corrode metal plumbing fixtures and pipes.

Cross-Connection:- Any connection that could allow wastewater to enter the potable water supply.

Discharge Tube:- Tube that connects sump pump to the drain line.

Dope:- Lubricant paste used for sealing pipe threads.

Dynamic Pressure:- The water pressure while water is flowing.

Elbow:- A fitting that has 2 openings, allowing a pipe line to change direction. Elbow are often referred to by their angle.

Elevation:- The vertical distance between the level at which fluid enters a pipe and the level at which it leaves the pipe.

Female Fitting:- A fitting into which a pipe or another fitting gets inserted.

Female Threads:- Threads that are on the inside of a fitting.

Ferrule:- A metal reinforcement insert that prevents the compression of a pipe as it enters fittings.

Fitting:- A pipe system component that joins together two sections of pipe. Examples include: elbows, couplings, bushings, bends, or tees.

Flexible Connector:- A braided hose connecting a faucet or toilet to the water supply stop valve. It is usually reinforced hose made from stainless steel, PVC, or polyester.

Float Ball:- A ball-shaped float that rises or falls with the water level in a tank or sump pit.

Floor Drain:- Drainage fitting that is positioned flush with the floor. It is used in basements and showers.

Flow Control Valve:- Device that reduces water flow to a plumbing fixture typically used to improve efficiency and lower water costs.

Flow Rate:- The rate that liquid flows, typically in gallons per minute (GPM) or gallons per hour (GPH).

Flux Paste:- It is applied to copper pipes and fittings before soldering takes place, in order to help the fusion process, while preventing oxidation.

French Drain:- A covered ditch that contains a layer of stone or other type of permeable material.

Friction Loss:- The loss of water pressure resulting from the turbulence created in water while it travels through a pipe.

Frost Line:- The depth that frost penetrates to, in the ground.

Ground Fault Circuit Interrupter (GFCI):- A device that cuts off the flow of electricity when a short circuit is detected.

GPH:- Gallons Per Hour.

GPM:- Gallons Per Minute.

Grey Water:- Waste water from sinks, showers, and bathtubs, although not toilets.

Ground Water:- Water that naturally rises in the ground from the water table.

Hanger:- A device that helps to support a pipe.

Hard Water:- Typically water hardness is a measure of calcium or dissolved solids, measured in parts per million. Hard water usually ranges from 100 to 250 ppm.

Head:- Water or steam pressure in a closed system - the difference in gravitational force exerted by a liquid at two different heights.

Hydraulic Pressure:- Pressure in a system that contains non-compressible liquid.

Hydrostatic Pressure:- Pressure exerted by liquid at rest. Typically pertains to water pressing inward against walls, foundations, or floors.

Inside diameter (ID):- Pipes are specified by their inside diameter.

Impeller:- A spinning wheel with vanes that is used inside a centrifugal pump. As it spins, it draws in fluid and moves it to the discharge outlet.

Integral Vacuum Breaker:- A device that keeps water from back-flowing into the fresh water supply.

Laundry Tub:- A deep sink found in a laundry room.

Male Iron Pipe Connection (MIPC):- External threads on pipe or fittings.

Main:- The primary water supply or drain artery of a system.

Male Fitting:- Fitting that gets inserted inside another fitting.

Non-Potable:- Water that is not suitable for drinking.

O-Ring:- Round rubber washer used to make a watertight seal.

OD:- Outside Diameter of a pipe.

Outlet/Discharge:- The opening that water exits a pump through.

PEX Cross:- Linked polyethylene tubing that has become increasingly used for water supply lines.

PSI:- Pounds per Square Inch

PVC Polyvinyl Chloride:- A rigid white or cream-colored plastic pipe that is used in non-pressure systems, for example, in drainage, waste, or vent systems.

Perforated Pipe:- A pipe that discharges water through small, closely spaced holes or nozzles for irrigation.

Pipe Dope:- Pipe-joint compound used to seal threaded fittings.

Pitch:- The slope of a drain pipe.

Potable Water:- Water suitable for drinking.

Pressure Head:- Pressure in a plumbing system.

Pressure Loss:- Measure of the loss of pressure that occurs whenever water moves through a pipe or when water moves uphill against the force of gravity.

Pressure Reducing Valve:- A valve that automatically reduces water pressure to a specified pressure.

Pressure Regulator:- A device used to maintain a uniform pressure.

Reducer:- Fitting connecting different sized pipes.

Scale:- A coating or layer, often of calcium, that can prevent heat transfer.

Schedule Numbers:- Specifies the thicknesses of pipe wall.

Sediment:- Substance that settles at the bottom of a water tank.

Solder:- A metal alloy, melted to fuse a joint between metal pieces.

Static Discharge Head:- Vertical distance from a pump to the highest outlet point in the water system.

Static Lift:- The vertical distance between the water level at the source and discharge of a pump system.

Static Pressure:- The pressure when water is not flowing.

Suction Head:- The head measured at the suction side of a pump. This is then subtracted from the discharge head to get the head being produced by the pump.

Sump:- A pit for draining or collecting water.

Sweating:- It refers to either soldering or condensation being formed on the outside of pipes or toilets.

Teflon Tape:- A fluorocarbon polymer used to wrap pipe threads to create a seal.

Vacuum Breaker:- An device that prevents siphoning and backflow. Keeps contaminated water from flowing backward into the water supply system.

Valve:- A device that regulates the flow of liquid.

Venturi:- A tube that is tapered in the middle, creating an increase in the flow velocity of a liquid and a corresponding decrease in its pressure. Used to creating suction in a vacuum pump.

Water Hammer:- A loud banging noise that is caused by the hydraulic shock from abruptly shutting off a water supply.

Water Hammer Arrestor:- A device that absorbs the hydraulic shock caused by a sudden water shutoff.

12.3 SANITARY FITTINGS

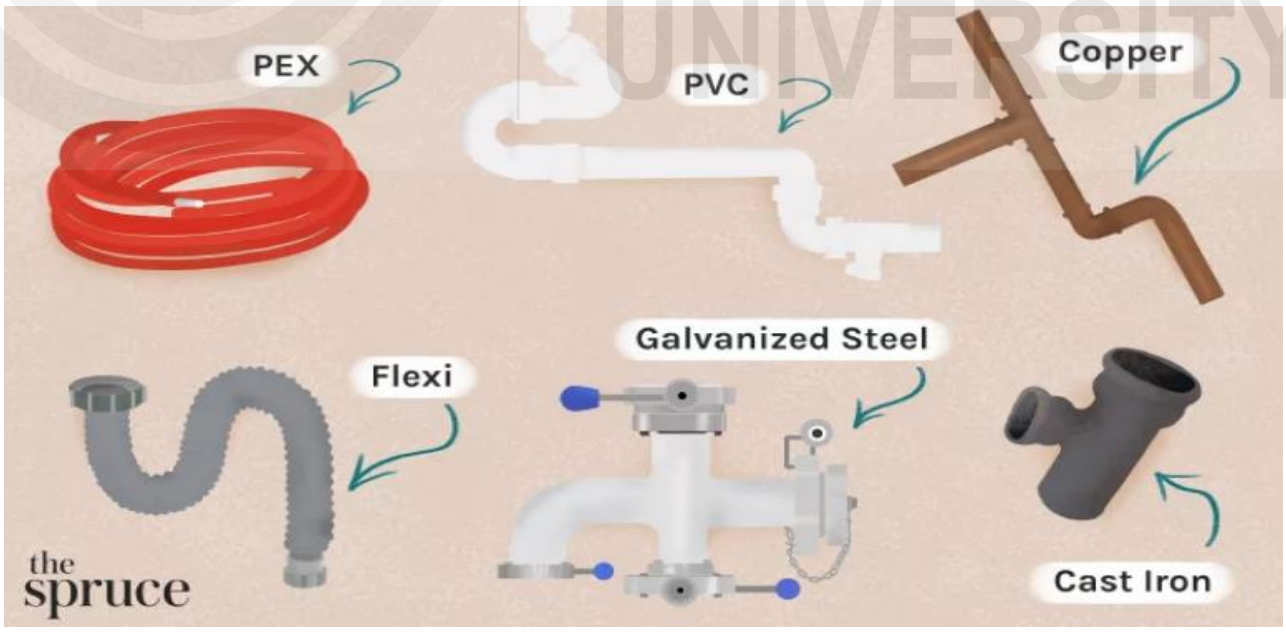
Sanitary fittings are clamping tools used to hygienically seal two ferrules together. They are also referred to as sanitary clamps or hygienic clamps.

Sanitary fittings are made with cleanliness and sterility in mind and are used in the food, beverage, medical, pharmaceutical, and biological industries. These kinds of fittings are made of components that guarantee sterility both before and after use.

Types of Water Pipes Used in Building

1. **PVC Pipes:-** PVC pipes are used for internal and external water supply system in buildings.
2. **Copper Pipes:-** Copper pipes of heavy gauge and light gauge are used for better grade houses and where ground-water is highly corrosive to steel pipes.
3. **Galvanized Iron Pipes:-** These pipes of heavy, medium and light grade are extensively used for water supply and drainage in building construction as they are economical.
4. **Lead Pipes:-** These pipes are highly corrosion resistant and flexible. Taps and stop-cocks in buildings are available from iron, brass and chromium plated varieties.
5. **Soil Pipes and Waste Pipes:-** These pipes remove sewage and grey water from and are connected to the common drainage system. They are generally fitted to the exterior of the building.
6. **Vent Pipe:-** Vent pipes are attached to the top of soil and waste pipe for the release of bad odours.
7. **Rainwater Pipes:-** These pipes are attached to the roof or open area above building for the removal or collection of rainwater.
8. **Anti-Siphonage Pipes:-** These are connected to the outlets of toilets which are provided to maintain water seal to prevent entry of foul gases of the sewer lines into the toilets and bathrooms.

Fig 12.1: Different Types of Pipes



Source: www.thespruce.com (retrieved on 16/11/2022@15:15)

Types of Commonly Used Pipe Fittings Used In Buildings

1. **Galvanized Iron Pipe:-** It is made of galvanized steel and in used to convey water from source to the point of use.
2. **Galvanized Iron Socket Or Bushing:-** They are small pieces of G.I. pipes with internal threads at both the ends to suit the outer threads of the pipes. For extension the pipes are screwed on both the ends of the socket. The pipes joints are made with cord and binding paste on the screw threads while fixing to check leakage.
3. **Galvanized Iron Reducing Socket:-** We require a reducing socket when a particular section pipe is to be joined with a different section pipe. The two ends of the socket are suitably sized and threaded to accommodate the two different sections of pipes.
4. **Galvanized Iron Bend:-** Bends are used for smooth change of the direction of the pipes. Commonly used bends are 90^o angle.
5. **Galvanized Iron Elbow:-** are modified sockets with a sharp bend at the middle. Elbow is used when the pipe is extension requires sharp change in direction. The commonly used elbows are of 45 and 90^0 angle.
6. **Galvanized Iron Tee:-** tee is a modified socket with an extension socket at 90^0 in the middle. It is used when we have to tap an extension branch, off the main running pipe at right angle.
7. **Reducing Tee:-** is required when a smaller section extension pipe is required to branch off a larger section pipe.
8. **Galvanized Iron Cross:-** is a modified Tee when two extension pipes in opposite directions are to be branched off at the same point of the main pipe. Crosses are available to accommodate large section main pipe and small sections of branch pipes.
9. **Galvanized Iron Union:-** unions are essential for facility of fitting and dismantling pipes at single or double bends zones of the pipe run. A cheaper alternative to union is running socket arrangement.
10. **Galvanized Iron Cap:-** cap is an internally threaded socket with one end closed or blocked. They are screwed on the open end of a pipe threads to check water wastage.
11. **Galvanized Iron Plug:-** are externally threaded solid blocks with a square-tightening end. They are screwed in the open socket ends of pipe to check water wastage when replacing taps etc.
12. **Gate Valves:-** Are used as on/off valves. They are operated either in completely closed or opened positions. Their resistance to water flow is minimal. These are used as shut-off valves on water mains.
13. **Angle And Globe Valves:-** are used for variable water flow. They have a high resistance to water flow when partially opened; thus, they restrict water flow. When completely opened, they have moderate resistance. These are used in bathtubs, showers, sinks and lavatories.

Fig 12.2: Different Types of Pipe Fitting

Source www.linquip.com (retrieved on 16/11/2022@16:00)

Types of Sanitary Fittings used in Buildings

1. **Hand Wash Basins:-** A bathroom fixture with taps, used for washing the face and hands.

2. **Sinks (glazed or stainless-steel sinks):-** A sink is a large fixed container in a kitchen, with taps to supply water. It is mainly used for washing dishes.

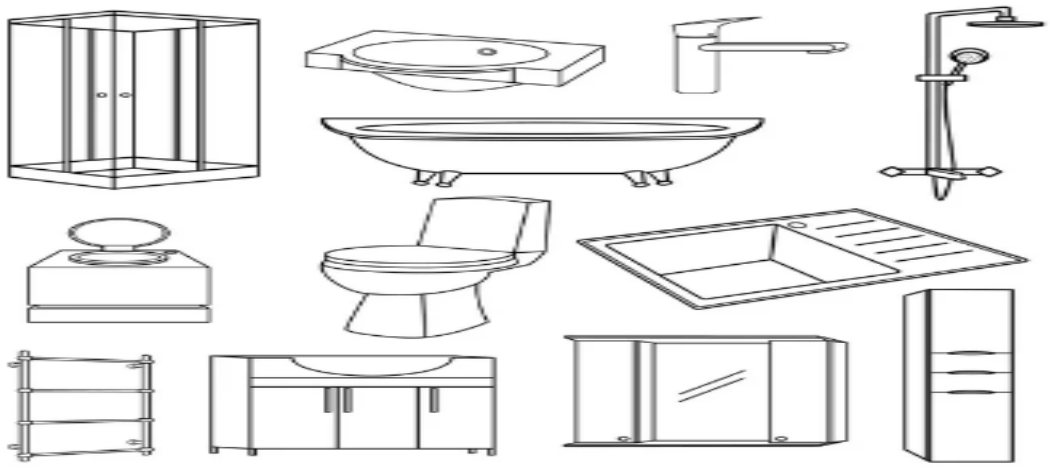
3. **Bath Tubs:-** A bathtub, also known simply as a bath or tub, is a container for holding water in which a person or animal may bathe

4. **Water Closets:-** A room containing a flush toilet.

5. **Urinals:-** a bowl or other receptacle, typically attached to a wall in a public toilet, into which men may urinate.

6. **Flushing Cisterns:-** Flushing cistern means a cistern with a discharging apparatus for flushing a water closet, slop sink, urinal or drain.

Fig 12.3: Different Types of Sanitary Fitting



Source www.depositphotos.com (retrieved on 17/11/2022@12:25)

Check Your Progress-1

1) Enumerate the following terms:

   a. Tap b. Trap c. Galvanized Tee d. Plumbing e. Sanitary

2) Differentiate between any two of the following:

   a) Flushing Cistern and Water Closet

   b) Galvanized Iron Cross and Galvanized Iron Union

   c) Rain Water Pipe and Vent Pipe

WATER SYSTEMS

Sources of Water

Chemically, water is hydrogen oxide (H2O). It is available on earth in all the three phases of matter. It participates in practically every ecosystem process and is vital for the living world.

Total earth water available covers about 71% of the earth's surface. The total quantity of water on earth is estimated at about 1400-mega cubic kilo-meter or 1.400x109 cubic km. Expressed in liters 1.4x1018 cubic meter or 1.4x1021 liter or 1.4x1021 kg approximately. The main approximate distributions of the water on earth are mentioned below:

- **Oceans: 97.0%**
- **Ice caps and Glaciers: 2.2%**

- **Under-Ground reservoirs: 0.6%**
- **Lakes, rivers, Soil moisture Biosphere, Atmosphere: 0.2%**

Total 100.0 %

Drinking Water Sources

The drinking water sources can be divided mainly as:

- Ground Water sources: rivers and big lakes constitute the main ground water sources. This being the reason those big ancient civilizations settled near riverbanks and perennial lakes.

- Under ground water sources: Ancient people had the knowledge about the underground water. They tapped it by digging shallow wells. With advancement of time and technology new and better types of wells were designed which could pump out large quantities of water from deep underground water reservoirs. The water from deep underground is plentiful, more clean, pure and potable. These days deep bore tube wells are a common arrangement for water supply.

Qualities of Potable Water:

- Should be free from turbidity and sparkling transparent. Turbidity should not be more than 5ppm.
- Should be colorless, absence of metallic oxides.
- Should be odorless, absence of organic and decomposed organic matter.
- Should be cool to drink, desirable temperature should be between 5* to 13*C.
- Should be tasteful to drink. Dissolved oxygen and carbon dioxide gases make water tasteful. This explains why boiled water is tepid (tasteless).
- Should be free from harmful dissolved chemicals.
- Should be free from dissolved foul and harmful gases e.g. hydrogen sulfide, ammonia.
- Should be free from dissolved inorganic matter such as fluorides. Excess of fluorides caused softening of bones.
- Should be free from water transmitted bacteria and pathogens.
- Should be free from radioactive impurities.
- Should be free of insecticides.
- Should not be hard.
- Should contain electrolytic salts in permitted quantity.
- Ph value should be 7, i.e. should be neutral.

Methods of Disinfecting Water:

- By Boiling.

- Lime Treatment.
- Bromine Treatment.
- Chlorine Treatment.
- Iodine Treatment.
- Ozone Treatment.
- Silver Treatment.
- Ultra Violet Treatment.
- Potassium per Magnate Treatment.

Water treatment removes contaminants and undesirable components, or reduces their concentration so that the water becomes fit for its desired end-use.

Water Systems

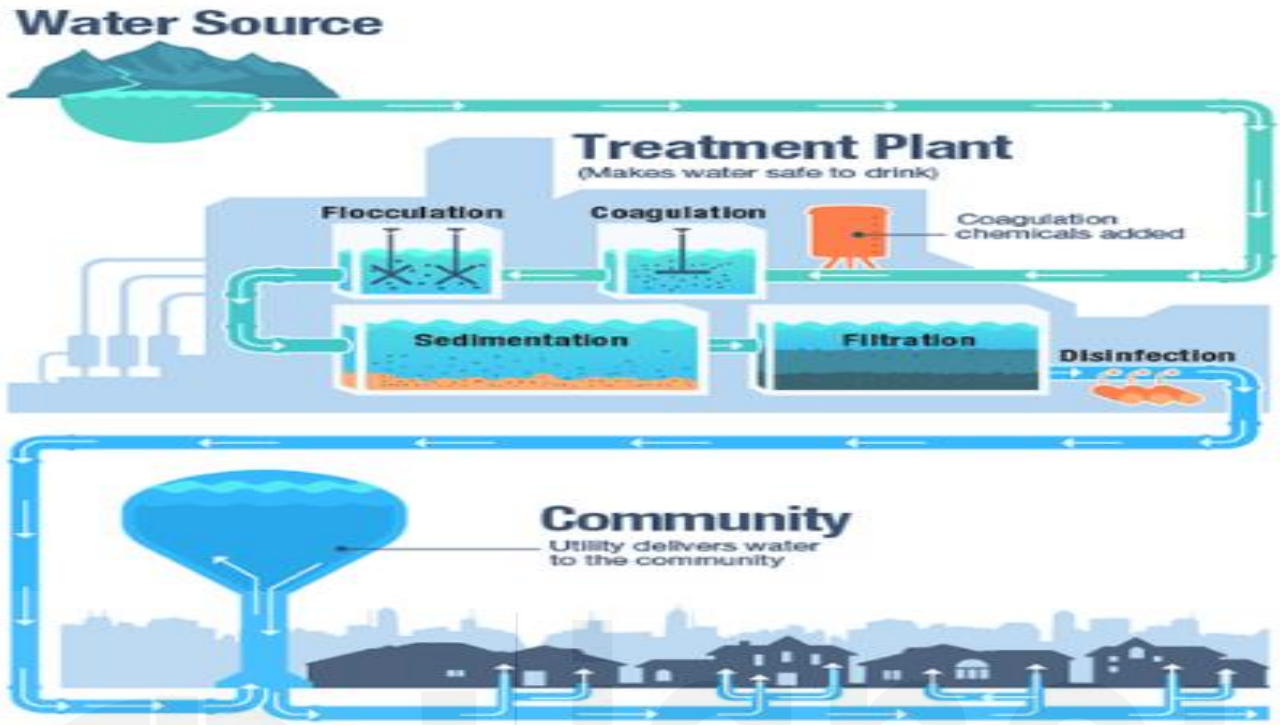
A water system is also known as water distribution system's primary job is to provide water from the treatment facility to the consumer. Additionally, distribution systems might offer storage in addition to proper flow and pressure for fire prevention. Water is most important amongst all and generally water provides by a public utility similar to electrical energy. Hospitality industries are totally dependent on supply of potable water and sanitary drainage network system.

Proper supply of clean water is becoming a global issue now a days and every country is putting their efforts to ensure supply of safe, hygienic and clean water to their citizens.

Water has become a very important energy resource. As we are aware that primary source of fresh water are lakes, rivers and ground water and because of pollution, rivers and lakes are polluted so there is an only one source remains that is underground. Extraction of water from the ground also becoming a serious problem because label of water in most of the areas are falling down, so there is an immediate need of recycling of water and its conservation.

Water must be treated to make it potable, that is, safe for human consumption. Treatment process depends on amount of water to be treated and on quality of extracted water.

Fig 12.4: Water System



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Stages in Water System

1. **Water Abstraction and Raw Water Transfer:-** A water resource's raw water comes from a surface water source or a groundwater source located inside the water shed. The raw water is transferred to the water purification facilities using uncovered aqueducts, covered tunnels or underground water pipes.

2. **Water Treatment:-** Water treatment is the process of removing all those substances, whether biological, chemical, or physical, that are potentially harmful to the water supply for human and domestic use. This treatment helps to produce water that is safe, palatable, clear, colourless, and odourless. Water also needs to be non-corrosive, meaning it will not cause damage to pipe work.

3. **Water Distribution Network:-** A water distribution system is a part of a water supply network that includes components that transport potable water from a central processing plant or well to consumers to meet residential, commercial, industrial, and fire fighting needs.

4. **Water Network Maintenance:-** Maintenance of water supply system is defined as the art of keeping the structures, plants, machinery and equipment and other facilities in an optimum working order and proper functioning without any interruption.

There are two types of maintenance:-

Preventive Maintenance constitutes routine works and precautions to be taken periodically to prevent the system from mal-functioning by mechanical adjustments, repairs, corrective action and planned maintenance.

Corrective Maintenance involves carrying out works related to break down, which has actually occurred by replacements, correction of defects etc.

5. **Sustainable Water Supply:-** Sustainable water supply means finding reliable and resilient solutions to a range of human water needs that do not deplete water sources, local economies, or have long-term negative impacts on the environment.

6. **Optimizing The Water Supply Network:-** Water Distribution Network optimization involves designing a reliable, efficient and cost-effective distribution network that meets the required water demand while maintaining adequate head pressure. This is important not only to conserve water resources, but also to reduce energy needs and maintenance costs.

7. **Sustainable Development:-** Sustainable water resource development means reducing water consumption and reusing wastewater for various uses such as purification, manufacturing and agricultural irrigation to ensure that future generations' water needs are not compromised.

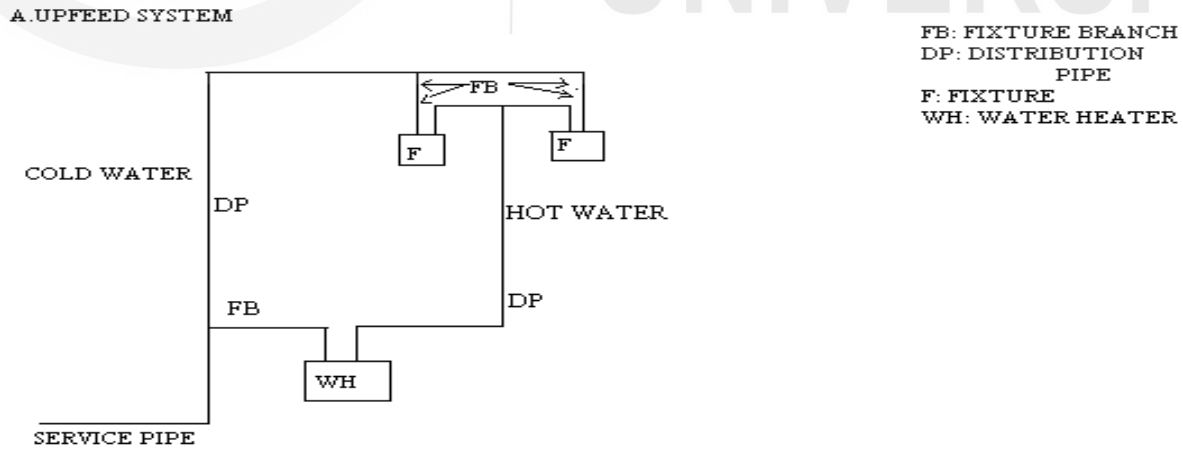
Water Distribution System

There are several water –distribution systems used in a facility depending on its size and area of the building, capacity, purpose and requirement:

1. **Up-Feed System**

It is most commonly used water distribution system when the pressure of water is sufficient to force water throughout a building of six floors or less in height. The maximum number of floors can be feeded with this system depends on pressure, resistance of pipe and the height of the building.

Fig 12.5: Up-Feed System

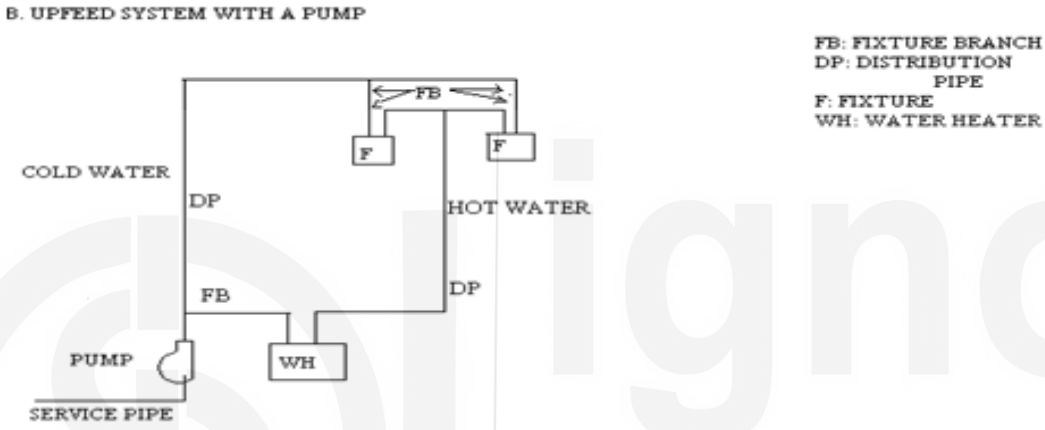


2. **Up-Feed System with Circulating Pumps**

This system is used when water pressure is inadequate and a circulating pump along with a return pipe is installed to increase water pressure and water to flow constantly throughout the

system. This is frequently used on hot –water lines to provide an adequate supply of hot water by making a provision of water heater.

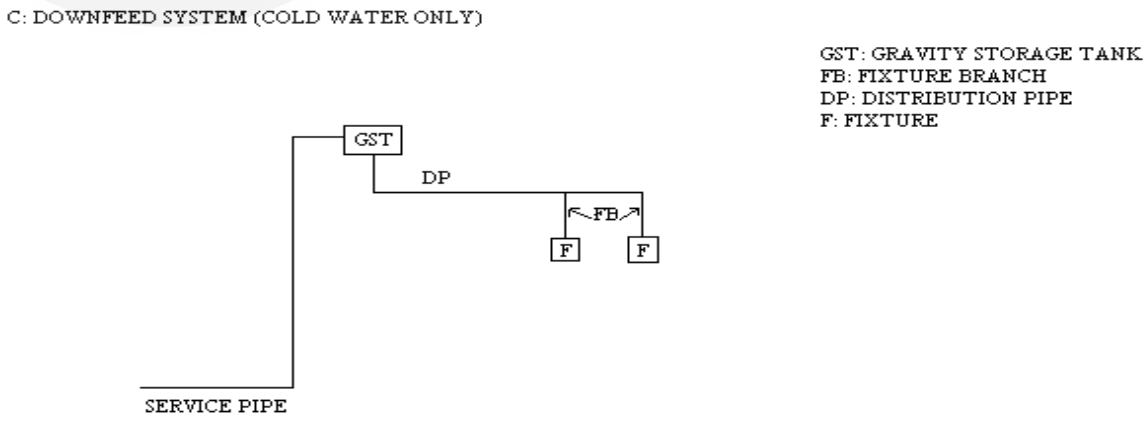
Fig 12.6: Up-Feed System with Circulating Pumps



3. **Down-Feed System** (cold water only)

In this system first of all water is forced or pumped to a storage tank (over head tank) located on the top floor of the building and when water is required, it flows by gravity from the storage tank to the tap. This system is used in very tall buildings.

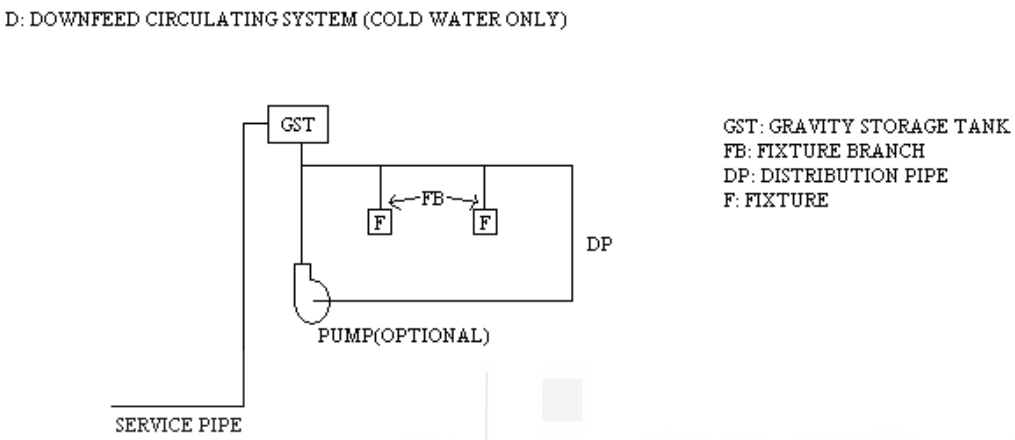
Fig 12.7: Down-Feed System



4. **Down-Feed Circulating System**

It is very similar to the circulating puffed system. This technique is frequently used with hot water to ensure adequate amounts of hot water at each fixture.

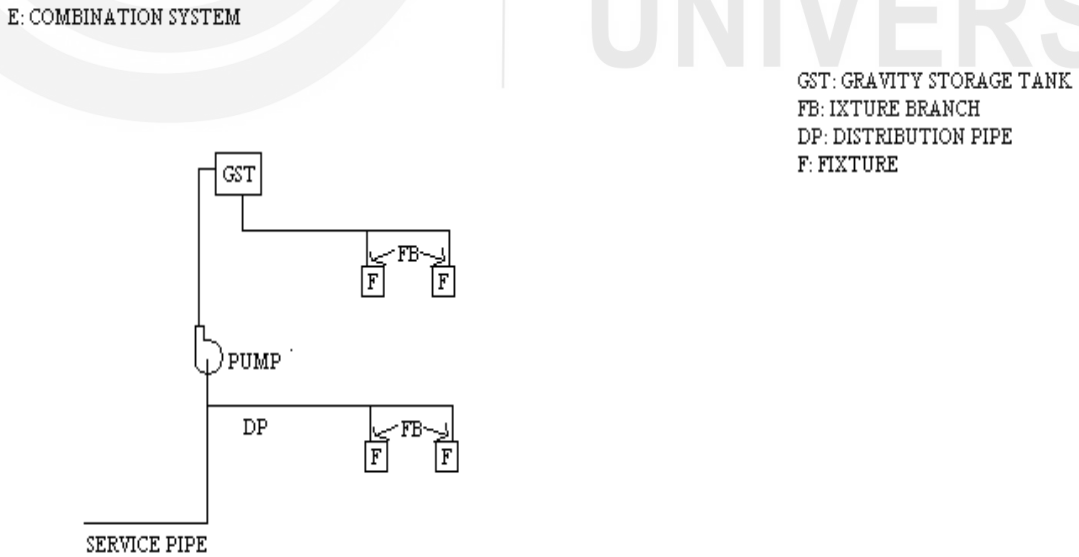
Fig 12.8: Down-Feed Circulating System



5. **Combination System**

It is a combination of up-feed-down-feed system. The up-feed system is used for the lower building levels and the down-feed system for the upper building levels. This system is probably the most efficient distribution system for multiple –floor hotel building because water –main supply pressure is utilized to the full extent and additional pressure is generated by pumps to reach water on water storage tank located on top floor of the building.

Fig 12.9: Combination System



Check Your Progress-2

1) **Enlist four sources of water.**

2) **Explain two techniques used in disinfecting water.**

3) **Enumerate various stages of water system.**

4) **Explain up feed water distribution system.**

12.4 HVAC (Heating, Ventilation, and Air Conditioning) SYSTEM OPERATIONS AND MAINTENANCE

Heating, ventilation, and air conditioning, or HVAC, are three services that an HVAC system might offer in a single installation. With heating and cooling systems to control temperatures, air is circulated by bringing in new; temperature-adjusted air from the outside and removing stale air back out.

At the most basic level, an HVAC system takes in air, cools or heats that air, and blows it into an indoor space. That space could be a specific room or an entire building or structure, such as a house, office, school, airport, or even a submarine.

HVAC maintenance involves checking, cleaning, testing, and maybe even repairing and replacing individual system parts in order to maintain the heater or air conditioner. You may avoid worse troubles with your HVAC system by investing in routine maintenance.

HVAC (Heating, Ventilation, and Air Conditioning) Terminology

1. Heat Flow:- Heat always flow from a warmer to a cooler substance. Heat causes some solids to become liquids or gases.

2. Cold:- It means low temperature or lack of heat. It is the result of removing heat.

3. Absolute Zero Temperature:- It is that temperature where molecular motion stops. It shows that there is no more heat in the substance at this point.

4. Pressure:- Pressure is the force per unit area, and it is expressed in Pascal (pa) and in kilopascals (Kpa).

5. Pascal's law:- It states that: pressure applied upon a confined fluid is transmitted equally in all directions. It is the basis of most hydraulic and pneumatic systems.

6. Humidity:- The word humidity refers to water vapour or moisture in the air. Air absorbs moisture (water vapour). The amount depends on the pressure and temperature of the air. The higher the temperature of the air, the more moisture it will absorb. The higher the pressure of the air, the smaller amount of moisture it will absorb. A relative humidity of 50% indicates the air has 50% as much as it will hold at that particular temperature and pressure.

7. Area measurement:- The measurement of area involves the measurement of two dimensional spaces.

For example : if width of a table top is 20 cm and length of the table is 30 cm then area of the table top is 20 x30 = 600 square cm.

8. Volume measurement:- The measurement of area involves the measurement of three dimensional spaces (cubic). The volume of an object is determined by multiplying the width by the length by the height.

9. Evaporator:- It absorbs heat and must be located in the space that is to be cooled. It can maintain temperature as low as the boiling point of the refrigerant.

10. Compressor:- There are two purpose of compressor:

a. To pump the refrigerant gas out of the evaporator

b. To increase refrigerant pressure.

11. Condenser:- The purpose of condenser is to release the refrigerant heat that was absorbed in the evaporator and during compression.

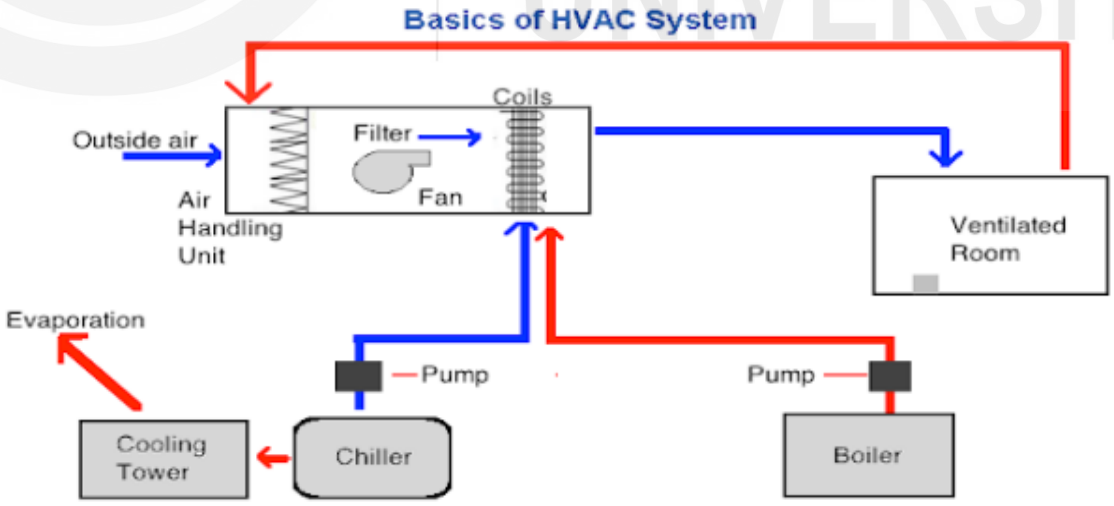
12. Expansion valve:- It is primary system control and activates the compressor. When the valve allows refrigerant to flow into the evaporator, it permits the compressor to operate; when the valve closes, it stops the compressor.

13. Tons of refrigeration:- A ton of refrigeration represents the rate of cooling when a ton (approximately 907 K gm or 2 000 lb) of ice melts during one 24- hour day.

14. Ambient temperature:- It means the temperature of the air surrounding a motor, a control mechanism, or any other device. It is not usually constant and may change day to day and hour by hour, depending on sunshine, space and many other factors.

15. Critical temperature:- The critical temperature of a substance is the highest temperature at which the substance may be liquefied, regardless of the pressure applied upon it. The condensing temperature for a refrigerant must be kept below its critical temperature. Otherwise, the refrigerator will not operate.

Fig 12.10: Basic HVAC System



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HVAC Steps For Preventative Maintenance:-

- Clean the condenser or heat pump
- Check the filter
- Regular or annual professional check-ups
- Clean the drain lines
- Keeping the outdoor unit clear
- Get a smart air conditioning controller or a smart thermostat

Air Conditioning System

According to the plant the air conditioning systems can be broadly divided into the following categories:-

1. **Window Types Units:** .Window type air conditioning units: are completely self contained units, with the compressor, condense, evaporator, refrigerant piping and air filter all assembled in a very compact assembly and fitted with an attractive frontage to harmonize with the interior of home or office. The window units are usually of half to two-tons capacity, and fitted with 230 volts motors up to 3 horse power.

2. **Floor Mounted Package Units:-** Floor mounted package units these units are functionally very similar to window models but are much bigger in size and therefore arranged at a suitable position on the floor of the conditioned space. These units are fitted flush with the window on the interior. The bulk of the unit hangs on the exterior of the window with support on brackets.

3. **Central Plant System:-** Central A.C. plant with air ducting: A central plant with full ducting is best suited for air conditioning of large buildings, such as theatres, halls and un-partitioned offices those having interiors which do not have an outside exposed wall. The conditioning plant consists of two or more heavy compressors including the attached essential components. These are located at central place preferably usually on the ground or basement level of the building. The conditioned air is delivered through a ducting system to all parts of the building. A duplicate ducting system is required to lead back the return air from the inside to the plant to be humidify/de-humidify and recharged with fresh air to be circulated again.

4. **Chilled Water System:-** Chilled water system are unit coolers in each room with independent fresh air inlet. This system overcomes the difficulties encountered of the above system. Water is used as the transfer medium to carry the heat absorbed in the rooms back to the central cooling plant where the water is cooled again. Individual heat exchanging units are provided in each room and chilled water is piped into the units. The cool water absorbs the room heat and is diverted back to the cooling plant.

Refrigerants

In refrigerating systems fluids which absorb heat inside the cabinet and release it outside are called refrigerants. These fluids, in their liquid form, under a pressure, absorb heat in the evaporator and, in absorbing heat, change to a vapour form, the fluids are taken into the compressor where the temperature and pressure are increased. This allows the heat that was absorbed in the evaporator to be released in the condenser, and the refrigerant is returned to a liquid form. These are the members of halocarbon family and are non-toxic, no corrosive, nonexclusive, and non-flammable. Refrigerants have a relatively low specific volume.

Properties of Good Refrigerants

1. It should be non-poisonous and non-irritant.
2. It should be non-inflammable and there should be no fire or explosion hazard.
3. It should be chemically stable and should not dissociate in extremes of temperature and pressure.
4. It should be non-corrosive, should not react with the working pars of the compressor, evaporator and radiator.
5. It should have no objectionable odour.
6. Could be easily and reliably detected in case of leakage.
7. The latent heat of vaporization be large to minimize the quantity of refrigerant.
8. The volume of vapour for a given weight should be low to reduce the size of the compressor.
9. The cost should be low.

Terminology of Refrigeration System

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1. **Extracting:-** This process extracts heat from a body or space and transferring it somewhere else will cool or lower the temperature of the desired body or space.

2. **Refrigeration:-** Is the process of cooling by extraction or pumping heat out of a body or space and transferring it to another with higher heat capacity.

Methods of Natural Cooling or Refrigeration:

1. **Conduction:-** A body is cooled by extraction of heat though conduction mode on keeping it in contact with another conducting body of lower temperature.

2. Convection:- A hot body is cooled when surrounded by a cool fluid. The cool fluids absorb and displace the heat away from the body by convection currents, thus the body looses heat and cools down.

3. **Radiation:-** A hot body when kept isolated in an evacuated cool space will continuously loose heat and gets cooled neither by conduction or convection but by a process known as Radiation.

4. **Evaporation:-** When a liquid evaporates it cools down on account of extraction of the latent heat of evaporation from its own mass and as result of this it gets cooled till the evaporation process continues, subsequently it can cool any object kept in contact with the evaporating liquid.

5. **By dissolving salts:-** Certain salts (ammonium chloride or ammonium nitrate) when dissolved in water the temperature of the solution is lowered. The cool solution in turn will cool the object in contact with it.

6. **Chemical reaction:-** Certain chemical reactions are endothermic, and are able to extract heat from the surrounding and lower the temperature.

7. **Cooling by refrigeration:-** Refrigeration is a cyclic process of extracting heat out of a closed space and transferring the heat to a space of higher temperature. The method depends on the absorption of the latent heat of evaporation of a working fluid. The vapours are then compressed and allowed to lose heat in a the warmer space and get condensed the condensed fluid is again used to absorb heat by evaporation and the cycle of operation is repeated.

Basic Refrigeration Cycles

Two systems of refrigeration are common in use:

1. Vapour Absorption System: This system does not involve any mechanical system. It cools a space by directly using the heat of an external source. The use of electricity for heating is optional.

2. Vapour Compression System: it is based on the electro mechanical process; the use of a compressor is essential.

Working Of The Vapour Absorption System:- It functions on the principle of vapour absorption principle. It consists of a highly concentrated water solution of ammonia or lithium bromide gas, which acts as the cooling medium or refrigerant. When the concentrated solution is heated the gas is liberated at high pressure. The high-pressure gas on cooling in the radiator liquefies into high-pressure liquid. The high-pressure liquid refrigerant is sprayed in the evaporating chamber. The sprayed refrigerant absorbs the latent heat of evaporation in the cooling chamber. After cooling, the low-pressure gas is reabsorbed in the leftover weak solution and turns into concentrated solution to repeat the cycle.

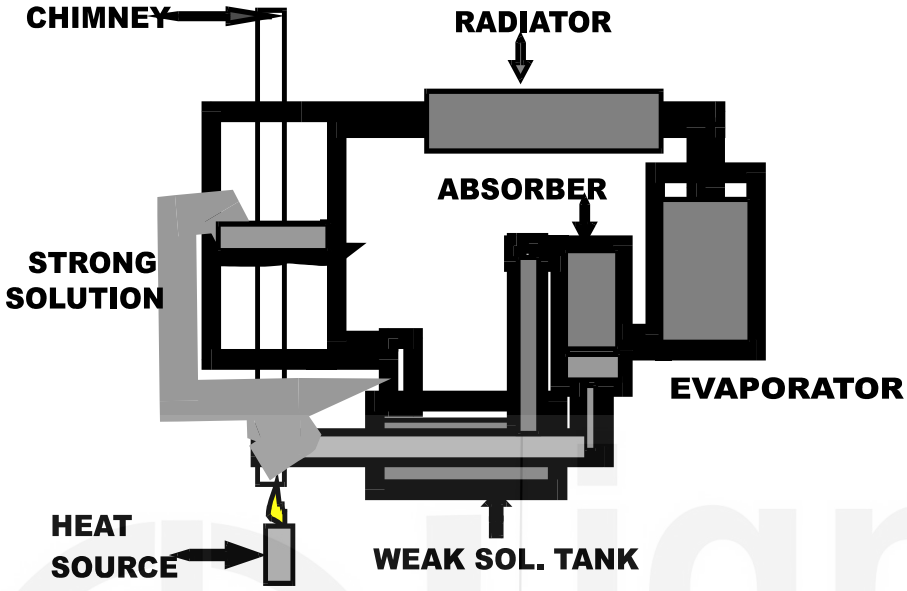
As already told it does not contain any mechanical moving parts. The heating arrangement need not be electrical; a wick type lamp may be used as the heat source. (See Fig 12.11)

It basically consists of the following sections and working stages:

- Generator: it is a strong tank, which contains the highly concentrated solution of refrigerant. On heating the concentrated solution, refrigerant gas is liberated at high pressure. The weak solution is diverted and collected in the weak solution reservoir.
- Radiator: the high-pressure refrigerant gas (ammonia) is directed to the radiator, where it loses its' heat and changes to high pressure liquid refrigerant.
- The liquefied high-pressure refrigerant is directed to the cooling chamber where it is sprayed. The liquid refrigerant spray readily evaporates and in the process it absorbs its latent heat of vaporization, necessary for change of state. As a consequence of this the evaporator is cooled and the cooling is used for further cooling of the desired closed space.
- Absorber: the low-pressure vapours are then directed to the absorber tank. The absorber tank is also connected to the weak solution reservoir from where it collects the weak solution. The gas is dissolved in the weak solution and turns it

into concentrated solution. The concentrated solution is then directed to the Generator through a heating tube to repeat the cycle.

- Heating source: the heat source may be a wick type kerosene lamp or an electric filament heater.

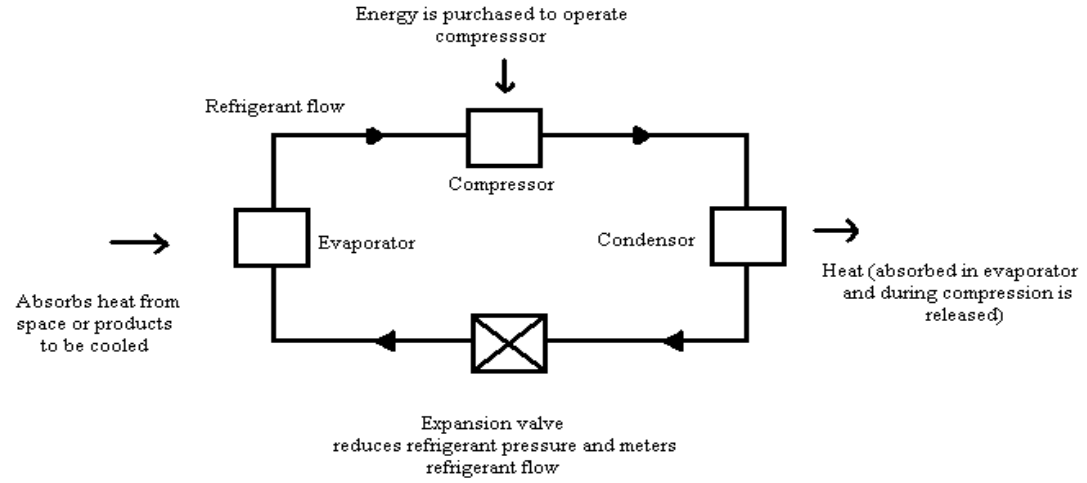


(fig.12.11)

ABSORPTION SYSTEM OF REFRIGERATION

Vapour Compression System:- This is electro-mechanical system, which makes use of temperature, pressure and latent heat of a suitable refrigerant, for pumping heat from a lower temperature to higher temperature level. In this system heat is absorbed by the by the refrigerant at a low temperature, and is discharged at a high temperature level into the atmosphere. That is why it is termed as 'Heat pump'.

Basically the system consists of the following four parts: (See Fig 12.12)



(Fig 12.12)

1. **Compressor:-** It has two fold function:

- It extracts the refrigerant gas from the evaporator or cooling chamber coils, as fast as they are formed at a low-pressure of 35 lbs/square inch.
- It compresses and delivers the gas to the condenser at a pressure of about 136 lbs/square inch. Because of the rapid high compression the gas becomes hot.
- The high-pressure gas is diverted to the radiator tube.

2. **Radiator or condenser:-** The hot high-pressure refrigerant gas is received at the upper end of the radiator tubing. The hot gas loses its heat across the radiator tube to the atmosphere and liquefies on the bottom side of the tube. The radiator tube may be cooled by air or water.

3. **Expansion valve:-** The high-pressure liquid refrigerant is diverted to an expansion valve just at the inlet of the evaporator chamber tubing. The function of the expansion valve is to control and regulate the flow of the high-pressure liquid refrigerant and allow it into the evaporator tube at low pressure.

4. **Evaporator:-** This constitutes the cooling unit, in which the liquid Freon (refrigerant) under a low pressure of about 35 lbs/square inch is sprayed in the cooling tubes. In doing so it quickly absorbs its quota of latent heat of evaporation and evaporates, thereby cooling the space medium surrounding the cooling coils.

The efficiency of the system depends mainly upon two factors:

- Compression efficiency: which is directly proportional to the compression ratio (high-pressure / low pressure)?
- The difference between the cooling coil temperature and the temperature at which the heat is rejected out of the radiator.

Care and Maintenance of Refrigeration System

- Do not place refrigerated equipment near sources of heat or near window area where the sun's rays will strike any portion of the unit.
- Keep the condenser clean and open to allow air to circulate around it.
- Dirt accumulations on the condenser serve as insulators and reduce the rate of heat transfer from the condenser to the environment.
- Ensure periodic vacuum cleaning of air cooled condenser.
- Kitchen grease may have to be removed by washing.
- Use best quality of insulation and must have a low thermal conductivity rating.
- Serious thought should be given to increasing thickness of insulation.

Air-Conditioning System

- Ensure correct ventilation system in a building.
- Air filters should be cleaned or changed at frequent intervals.
- Motor and fan bearings should be proper greased or oiled.
- Ensure insulation of ducts.

- Check interiors of the ducts periodically.
- If belt driven connections are used between the fan and motor, belt slippage must be to keep a minimum.
- An energy management system may also include ventilation control.

Energy Management Systems for Refrigeration Cycles

By introduction of computer controlled energy management system, considerable savings can be made by the owner of the property. This system continually monitors temperature of compressor, condenser, evaporator, and cooled space. As temperatures are continuously monitored in the cool areas an undesirable high temperature could activate an alarm if stored products are in potential danger. The system can control expansion devices and compressor operating times. The same system can be installed food chillers or freezer entrances by personnel. A well qualified refrigerator engineer or mechanic can quickly review temperatures and identify if a refrigeration cycle is operating efficiently. The EMS will also control performance of cooling tower and regulate the flow of water or air. A well designed and maintained computer EMS can reduce energy consumption by 20% or more, reduce the cost of spares, maintenance cost, and equipment –down time, reduce product spoilage etc.

12.5 FACTORS INFLUENCING BUILDING COMFORT

In contrast to commercial buildings, residential buildings typically place less emphasis on comfort assessments. Despite having more control than in offices, residents can still have health and comfort problems in their homes due to unfavourable environmental conditions, which can lead to adjustments that may increase energy consumption in buildings.

1. **Personal factors:-** Factors such as height and weight, age, fitness level, and gender can all affect mood, so thermal comfort should always be considered when considering other factors such as temperature, humidity, and wind speed. It is necessary to consider the physical characteristics of a person. Are all constant.

2. **Health and Wellbeing factor:-** Comfort is closely related to wellbeing, which was defined by Dodge et al (2012) as '…when individuals have the psychological, social and physical resources they need to meet a particular psychological, social and/or physical challenge'. Wellbeing incorporates other factors such as employment and relationship status, rather than just physical comfort within an environment.

2 Health issues which can occur to a human body are:-

a) **Building related illnesses (BRI)** are allergic reactions or infections which can be directly attributed to being in the building.

b) **Sick building syndrome (SBS)** relates to symptoms of acute health and/or comfort effects for which no specific cause can be found but that can be attributed to time spent in a particular building.

3. **Thermal Comfort Factor:-** Thermal comfort is a state of mind that expresses satisfaction with the thermal environment. The human body can be thought of as a heat engine where food is the input energy. The human body gives off excess heat to its surroundings, allowing the body to continue working. Heat transfer is proportional to the temperature difference. In cold environments, the body gives off more heat to the environment, and in hot environments, the body does not give off enough heat. Both hot and cold scenarios cause discomfort. Maintaining this standard of thermal

comfort for the occupants of buildings and other enclosures is one of the most important goals of HVAC designers.

4. **Indoor Air Quality Factor:-** Most pollutants affecting indoor air quality come from sources inside buildings, although some originate outdoors.
5. **Visual Comfort Factor:-** A suitable amount of natural light (and, secondarily, artificial light), effective glare reduction, and availability of views of the outdoors are the hallmarks of visual comfort.
6. **Noise Nuisance Factor:-** The word noise is derived from the Latin word 'Nausea', which means sickness in which one feels the need to vomit. Noise and nuisance together can be considered as the unpleasant and undesirable sound which leads to discomfort in human beings. The intensity of sound is measured in decibels (dB). The faintest sound that the human ear can hear is 1 Db. Due to increasing noise around the civilizations; noise pollution has become a matter of concern. Some of its major causes are vehicles, aircraft, industrial machines, loudspeakers, crackers, etc. When used at high volume, some other appliances also contribute to noise pollution, like television, transistor, radio, etc.
7. **Ergonomics Factor:-** Ergonomics factor (also known as human factors) uses theory, principles, data, and methodologies to design in order to maximise human well-being and total system performance. Ergonomics is the study of how humans interact with other components of a system in favour of their comfort.

Check Your Progress-3

1) Explain with the help of neat diagram vapour compression cycle.

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2) Write three characteristics of good refrigerant.

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3) Discuss factors influencing building comfort.

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12.6 LETS SUM UP

Comfort is the most important aspects of a human life. This chapter highlights about the elements of comfort conditioning inclusive of temperature control, humidity control, flow of

air and air treatment by using HVAC system. Supply of potable water in all the corners of a facility also discuss in this unit. Terminology plays an important role in facility management and it helps to understand the facility manager about various parts, processes and building systems. Maintenance of plumbing fixtures and HVAC along with energy management systems are given due weightage and emphasis in this unit. The best understanding of the topic will help you as an efficient and effective facility manager.

12.7 KEY WORDS

Absorption:- The process of a liquid, gas or other substance being taken in.

Abstraction:- A general idea not based on any particular real person, thing or situation.

Arrestor:- A thing that stops or checks motion,

Distribution:- The act of giving or transporting something to a number of people or places.

Encountered:- To experience something.

Flexible:- Able to bend or move easily without breaking.

Galvanized:- To cover iron or steel in a whitish metal (zinc) to protect it from being damaged by water (rusting).

Influencing:- To have an effect on or power over somebody/something so that he/she/it changes.

Optimizing:- Make the best or most effective use.

Sanitary:- Connected with the protection of health.

Thermal:- Connected with heat; Made to keep you warm in cold weather.

12.8 CLUES TO ANSWER

Check Your Progress-1

1) For details refer to 12.2
2) For details refer to 12.2

Check Your Progress-2

1) For details refer to 12.3
2) For details refer to 12.3
3) For details refer to 12.3

Check Your Progress-3

1) For details refer to 12.4
2) For details refer to 12.4
3) For details refer to 12.5

12.9 FURTHER READING

1) Plumber practical 1st edition by Manish sharma

Publisher - Neelkanth publisher's private limited 2021

2) Basic plumbing revised edition by Howard C. Massey

Publisher:- Craftsman Book Company 1994

3) Plumbing by R. D. Treloar

Publisher:- Wiley-Blackwell 2011

4) Water supply engineering by Dr. B. C. Punmia, Er. Ashok Kumar Jain, Dr. Arun K. Jain

Publisher:- Laxmi Publications 2008

5) Water supply engineering by Santosh Kumar Garg

Publisher:- Khanna Punishers

6) Sanitary Plumbing and Drainage by John W. Hart

Publisher:- Forgotten Books 2018

7) Comprehensive HVAC System Design by N.C. Gupta

Publisher - MV Learning

8) HVAC Engineer's Handbook by F. Porges

Publisher:- Taylor & Francis Ltd 2000

9) HVAC And Refrigeration Preventive Maintenance by Eric Kleinert

Publisher:- Mcgraw Hill 2014

10) Basics of HVAC System for Beginners by Kaylynn Lawson

Publisher:- Independently Published 2021

12.10 ACTIVITIES

1. Visit and observe an under-construction building and see how they are planning plumbing and drainage.
2. Visit and observe the how the water distribution system and water treatment is done in your locality.

3. Observe type of water supply system is mostly being used in your locality.