Environmental Sanitation

III year-I Semester

Unit-1

Epidemics, Epizootics

Learning Material

Epidemic

An epidemic is the rapid spread of infectious disease to a large number of people in a given population within a short period of time, usually two weeks or less. For example, in 2009 Gujarat hepatitis B outbreak that appeared in Modasa, northern Gujarat, India. Over 125 people were infected and up to 49 people died.

An epidemic may be restricted to one location; however, if it spreads to other countries or continents and affects a substantial number of people, it may be termed a pandemic.

The term "Epidemic" and "Outbreak" have often been used interchangeable.

- ***Epidemic diseases:***

- ✓ Cholera
- ✓ Small Pox
- ✓ Tuberculosis
- ✓ Malaria
- ✓ Filaria
- ✓ Plague

Epizootics

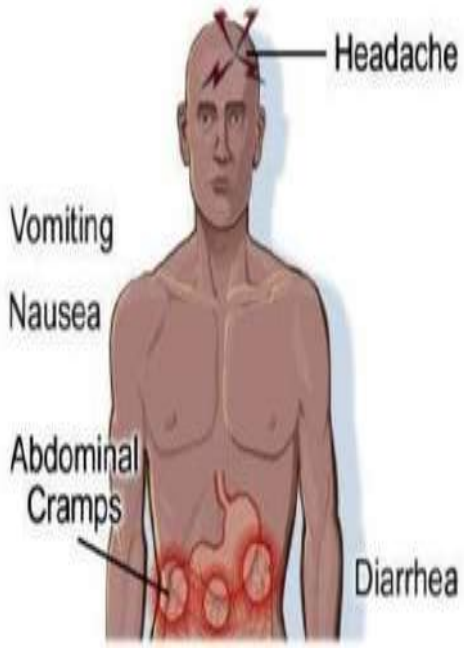
- An epizootic is a disease event in a nonhuman animal population, analogous to an epidemic in humans.
- In 2000, the Tungro virus, transmitted by white flees, caused enormous damage to the rice crop in West Bengal.

- An example of an epizootic would be the 1990 outbreak of new castle disease virus in double-crested cormorant colonies on the Great Lakes that resulted in the death of some 10,000 birds.

Cholera:

- Cholera is an acute epidemic infectious disease. It caused by ingestion of food or water contaminated with the bacteria. Cholera remains a global threat to public health and an indicator of in equity and lack of social development.
- Researchers have estimated that every year, there are roughly 1.3 to 4.0 million cases and 21000 to 143000 deaths world wide due to cholera.

Drinking contaminated water



Cholera symptoms

Symptoms of cholera:

Vomting

Diarrhea

Crampting

Severe dehydration

Symptoms of cholera can begin as soon as a few hours or as long as five days after infection. Often, symptoms are mild. But sometimes they are very serious.

Cholera Causes:

The cholera is usually found in contaminated food or water. Common sources include:

- Muncipal water supplies
- Food and drinks sold by street vendors
- Vegetables grown with water containing human wastes
- Raw or undercooked fish and sea food caught in wastes.

Cholera is also called blue death because it start half a day to five days after the person get infected. The skin turns bluish gray.

Smallpox

Smallpox was an infectious disease caused by one of two virus variants, Variola major and Variola minor.

The last naturally occurring case was diagnosed in October 1977 and the World Health Organization (WHO) certified the global eradication of the disease in 1980.

The risk of death following contracting the disease was about 30%, with higher rates among babies.

Rashes on body

Most people with smallpox recovered, but about 3 out of every 10 people with the disease died.Smallpox spread from one person to another person.

Symptoms of Smallpox

- ✓ high fever
- ✓ chills
- ✓ headache
- ✓ severe back pain
- ✓ Vomiting
- ✓ Head and body rashes

Rashes: A rash starts as small red spots on the tongue and in the mouth. It spread large amount of the virus in to the mouth and throat. The person continue to have a fever. After that rash appears on the skin, starting on the face and spreading to the arms and legs, and then to the hands and feet. Usually, it spreads to all parts of the body within 24hours. As this rash appears, the fever begins to decline and the person may start to feel better.

Tuberculosis:

Tuberculosis (TB) is caused by bacteria that most often affect the lungs. Tuberculosis is curable and preventable.

TB is spread from person to person through the air.

Tobacco use greatly increase the risk of TB disease and death 7.9% of TB cases worldwide are attributable to smoking.

Global impact of TB:

TB occurs in every part of the world. In 2017, the largest number of new TB cases occurred in the South-East Asia and Western Pacific regions, with 62% of new cases, followed by the African region, with 25% of new cases.

Symptoms

Tuberculosis may infect any part of the body, but most commonly occurs in the lungs.

General symptoms include

Fever

Chest pain

Weight loss

Night sweat

Malaria:

Malaria is a disease caused by a parasite. The parasite is transmitted to humans through the bites of infected mosquitoes.

Symptoms:-

A malaria infection is generally characterized by the following symptoms:

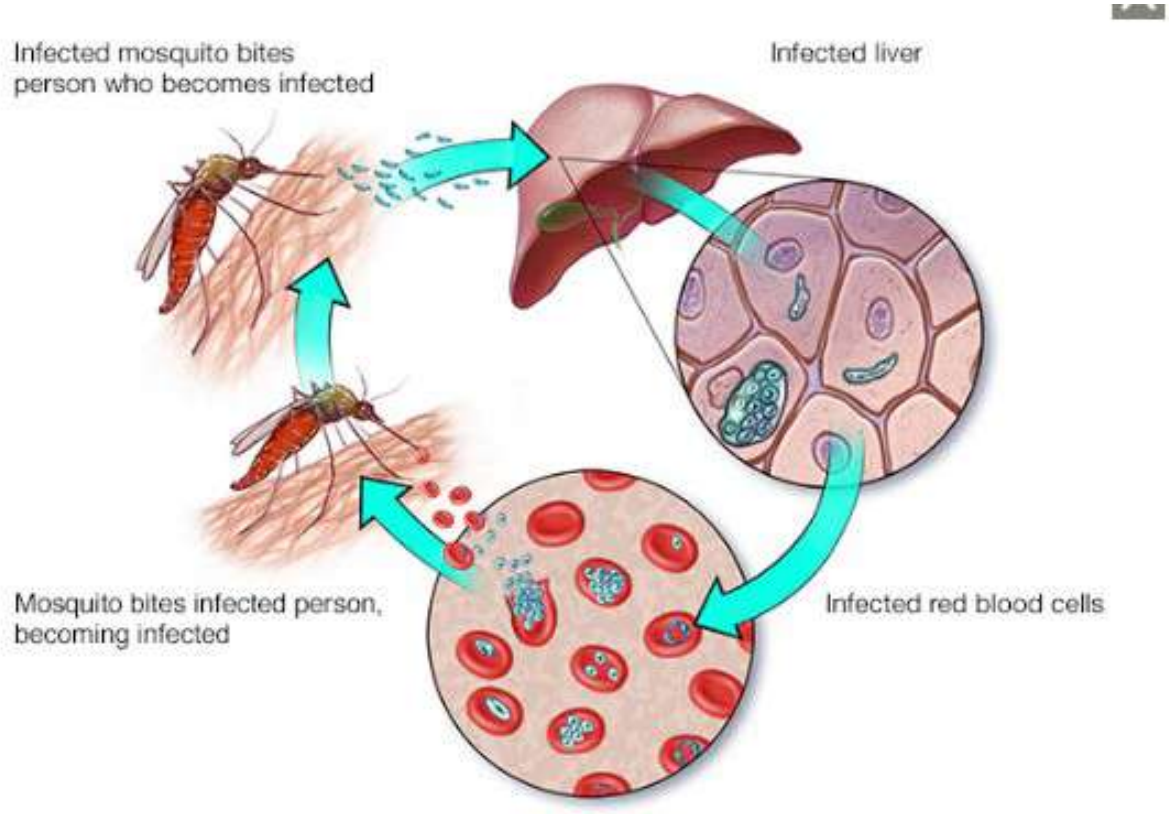
- ✓ Fever
- ✓ Chills
- ✓ Headache
- ✓ vomiting
- ✓ Muscle pain
- ✓ Sweating
- ✓ Chest pain

Some people who have malaria experience cycles of malaria "attacks." An attack usually starts with shivering and chills, followed by a high fever, followed by sweating and a return to normal temperature.

Malaria signs and symptoms typically begin within a few weeks after being bitten by an infected mosquito.

Mosquito transmission cycle

- ✓ Uninfected mosquito. A mosquito becomes infected by feeding on a person who has malaria.
- ✓ Transmission of parasite. If this mosquito bites you in the future, it can transmit malaria parasites to you.
- ✓ In the liver. Once the parasites enter your body, they travel to your liver — where some types can lie dormant for as long as a year.
- ✓ Into the bloodstream. When the parasites mature, they leave the liver and infect your red blood cells. This is when people typically develop malaria symptoms.
- ✓ On to the next person. If an uninfected mosquito bites you at this point in the cycle, it will become infected with your malaria parasites and can spread them to the other people it bites.



Malaria spreads when a mosquito becomes infected with the disease after biting an infected person, and the infected mosquito then bites a noninfected person. The malaria parasites enter that person's bloodstream and travel to the liver. When the parasites mature, they leave the liver and infect red blood cells.

Filaria:

Filaria is a parasitic disease caused by an infection with roundworms of the Filarioidea type.These are spread by blood-feeding diptera of mosquitoes. This disease belongs to the group of diseases called helminthiases.

The most spectacular symptom of lymphatic filariasis is elephantiasis – edema with thickening of the skin and underlying tissues —which was the first disease discovered to be transmitted by mosquito bites.

Elephantiasis results when the parasites lodge in the lymphatic system.

Plague:

The plague is a serious bacterial infection that can be deadly. Sometimes referred to as the “black plague,” the disease is caused by a bacterial strain called Yersinia pestis. This bacterium is found in animals throughout the world and is usually transmitted to humans through fleas

Plague is divided into three main types — bubonic, septicemic and pneumonic — depending on which part of your body is involved. Signs and symptoms vary depending on the type of plague.

The plague bacteria, Yersinia pestis, is transmitted to humans through the bites of fleas that have previously fed on infected animals, such as:

- ✓ Rats
- ✓ Mice
- ✓ Squirrels
- ✓ Rabbits
- ✓ Prairie dogs
- ✓ Chipmunks
- ✓ Voles

The bacteria can also enter your body if a break in your skin comes into contact with an infected animal's blood. Domestic cats and dogs can become infected with plague from flea bites or from eating infected rodents.

Pneumonic plague, which affects the lungs, is spread by inhaling infectious droplets coughed into the air by a sick animal or person.

Plague outbreaks are most common in rural and semirural areas that are overcrowded, have poor sanitation and have a high rodent population. The greatest number of human plague infections occur in Africa, especially the African island of Madagascar. Plague has also been transmitted to humans in parts of Asia and South America.

Prevention of Plague:

No effective vaccine is available, but scientists are working to develop one. Antibiotics can help prevent infection if you're at risk of or have been exposed to plague.

Take the following precautions if you live or spend time in areas where plague outbreaks occur:

- ✓ Rodent-proof your home. Remove potential nesting areas, such as piles of brush, rock, firewood and junk. Don't leave pet food in areas that rodents can easily access. If you become aware of a rodent infestation, take steps to control it.
- ✓ Keep your pets free of fleas. Ask your veterinarian which flea-control products will work best.
- ✓ Wear gloves. When handling potentially infected animals, wear gloves to prevent contact between your skin and harmful bacteria.
- ✓ Use insect repellent. Closely supervise your children and pets when spending time outside in areas with large rodent populations. Use insect repellent.

Role of Vectors in transmitting diseases

GENERAL

- ✓ Insects are the small invertebrate segmented living being. The vectors carriers of disease are anhopods or other invertebrates which transmit infection by inoculation into or through the skin mucous membrane by biting or by deposit 0f infective materials on the food or skin or other objects. Mosquito and house fly are the main carrier of diseases.
- ✓ House fly is the most abundant and familiar non-biting insect around the human habitation during the warm months of year. Whereas the other flies spread the diseases by inoculation through biting, the house flies spread the diseases mechanically. The nuisance of house flies as health menances can be reduced. if the human excreta is disposed off properly and if the flies are excluded from sickrooms and prevented from coming in contact with infectious wastes.

1. HOUSE FLY AS DISEASE CARRIER

- ✓ The female lays about 250 eggs in 25 days in any moist. rotting or fermenting material within 4-12 days after its full growth. The manure of horse, hog, cow, chicken, garbage, poorly digested sewage sludge, human excreta and sewage, decaying vegetables and fruits etc. serve as good fly breeding place. In warm climate, the larvaes hatch out in

10-24 hours from the eggs, become pupae in 4-10 days and adult insects in 3-8 days, The flies usually remain with 300-1000 m in the vicinity of breeding places, but wind may carry it up to20-25 km.

- ✓ The hairy body and sticky padded feel of the fly may carry as many as 6,00,000 micro-organisms. The house fly may carry the disease bacteria in its digestion system for as long as 4 weeks and may be transmitted to the next generation, While feeding on the filthy material, the fly covers its legs, body and wings with germs. As it is necessary for fly to transform the solid diet into liquid form. It does so by regurgitating some of the liquids already swallowed until the relatively solid matter is softened sufficiently to be swallowed
- ✓ But as all the regurgitated liquid is not taken in again. the fly leaves behind part of its vomit in addition to bacterias from legs and excretion from its intestinal canal on the surface sit sits during flying from one place to another. The house fly serves as carrier of disease bacterias like paratyphoid, typhoid fever, bacillary and amoebic dysentery, cholera, gastroenterities, pulmonary tuberculosis, poliomyelities, diarrhea etc.

1.1. FLY CONTROL

The maintenance of the entire living area in good sanitary condition is the first thing which helps in the fly control. Breeding places of fly should be eliminated and larvae adults should be destroyed the elimination of fly breeding places can be obtained by cleanliness, by good house keeping and application of recommended sanitary control measures etc. The storage of garbage and solid refuse should be done in covered and washable sanitary containers. All the privies should be kept in sanitary conditions. Waste water and sewage should be discharged efficiently into sewers. Sewage sludge should be treated and disposed off properly. All the refuse, sludge and standing water in the locality should be sprayed with kerosene oil or other insect killing chemical. Destruction Of fly larvae should be done by spraying fuel oil or kerosene oil in the breeding places. Diesdrin, Aldrin, DDT, solution of chlordane etc. may be sprayed around garbage heaps, stockyards. chicken areas etc. Toprevent the fly nuisance. For keeping the houses free from fly, they should be fitted with Wire mesh doors provided with automatic door closing springs.

2. MOSQUITO AS CARRIER OF DISEASE

Malaria is considered as the most important of the mosquitooorne diseases. This disease spreads in warm tropical regions, which favour the breeding of malarial mosquito. The mosquito as a carrier of disease, first obtains the parasite or causative organism while feeding upon the blood of a infected animal or man and then injects it into a susceptible individual person.

Therefore, the effective control or mosquito borne disease require elimination of the mosquito. Malaria is caused by certain parasites which live in the blood of an infected person. The mosquito is infected by ingesting some of the sexual forms of parasite along the blood of the infected individual. After 10-21 days development period. These malaria or organisms reach the salivary gland of the mosquito and are injected into the blood of the next person. Therefore, it should be noted that unless their development period is completed, the mosquito does not become infective.

2.1. MOSQUITO CONTROL

The irrigation channels, rivers, lakes, pond, embankment construction, leaky water pipes, inefficient sewage and effluent disposal etc, are main sources of breeding mosquitoes. The mosquito control measures include larvicidal and anti-adult methods, In the larvidical method the ditches, drains are improved or sprayed with DDT/kerosene oil ; the streams, street drainage, subsurface drainages are maintained; the depressed areas where water is staganed are filled up. The natural enemies of mosquito such as dragon Iife, birds and bats are also destroy the mosquitoes, by eating them, their larvae and pupae. The fish is also a very useful larvicide. The adult methods include the spraying of DDT and other insecticides for killing the mosquitoes and their larvaes.

MISCELLANEOUS INSECTS CONTROL

Other insects such as tick, chigger, louse. bedbugs. roach, sand fly. ant. white ant, etc. should also be destroyed for comfortable living and protection of building and other daily useable articles. DDT and other suitable insecticides are available in the market, which can be used for killing these insects.

RODENT CONTROL

- ✓ Rodents include mice, squirrel, beaver, porcupine, rat, rabbit etc. Out of these rats are the main source of nuisance in the houses. Domestic rats and other rodents are the carriers of disease germs, fleas, lice, mites, intestinal parasites etc. due to their wide distribution and close association with the man. They are responsible for damage and eating large quantity of food grains and other eatables. Rat population in India is estimated to be 3000 millions and the annual loss caused to food grains by the rodent population is 2.7 million tonnes, which is about 2-4% of the total production of agriculture.
- ✓ Rats are responsible for spreading typhus fever. plagues, rat bite fever, jaundice. amoebic dysentery , trichinosis , etc. Rat control measures include rat-proof construction of storage bins. trapping. fumigation. poisoning, destruction by natural enemies, elimination of

food. water and harbourgages etc. For the effective implementation of the rat control measures, Cooperation of public and the concerned department is essential. Better sanitation with proper refuse disposal is the most effective method of rat control. By the elimination of insanitary conditions, protecting food. water and harbourages. the rat problem can be solved up to great extent because the population of rats mainly depends on the availability of food. and harbourages for them. Closely fitted covers should be provided for the garbage bins.

- ✓ In the houses the food and grains should be kept in covered containers and the floors should be Washed or swept for removing the traces or bits of the food. Candles. wax products, soaps, fruits vegetables and other eatables should be stored in rat proof bins. All the rat in houses and fields should be sealed and walls. doors should be kept in good condition so that rats may not enter the premises.
- ✓ Rat control can be done by fumigation, but it should be done only in suitable places for it. It is extensively used to freeships or rodents and other vermins. HCN is the most effective fumigant gas, but this gas is deadly poisonous to human also, therefore it should be used with great care. Calcium cyanide is granular or powderd form may be pumped in to rat holes.
- ✓ While doing fumigation in buildings and other indoor areas, they should be tightly closed and the cracks sealed. The building should be kept open for atleast 4 hours for ventilation, after fumigating. Rats can be destroyed most efficiently by poisoning. Arsenic, strychnine, phosphorus, barium carbonates etc. can be used for rat killing. These poisons are mixed With fish, cereal , meat or bread and are kept in the corners of the rooms. The rat burrows may be gassed with auto exhaust, calcium cyanide, SO2 chlorine etc for killing rats.

Environmental Sanitation

III year-I Semester

Unit-II

Rural Water Supply and Sanitation

Learning Material

Sanitary Protection of Wells

1. Location:

The location of a well is one of the most important considerations in ensuring its sanitary quality. A location should always be selected which will prevent, as nearly as possible, contamination by percolation through the soil. Water or waste water will generally percolate vertically through the soil until it reaches the water table. When it reaches the water table, it will follow the general direction of flow of the underground water. This flow normally approximates the contours of the earth's surface, but not necessarily. Wherever possible, a well should be located up hill from a possible source of contamination: however, this is not positive assurance that the point at which the well draws water from the water table is not below the level at which contamination may be carried by percolation into the water table. In order to minimize this possibility, wells should be located at least the following distances from sources of pollution

a) Building sewer--100 feet.
(b) Septic tank--100 yards.
(c)Sewage disposal field--100 yards.
(d) Seepage pit--100 yards.
(e) Dry well--should be sealed.
(f)Cesspool--100 yards

NOTE:
Where there is good reason to believe that the soil is quite permeable, such as a limestone formation, these distances should be increased

2. Construction:

(a) The annular space between the well casing and the surrounding soil formation should be filled with watertight cement grout from the surface to a depth of at least 10 feet.
(b) The casing should be surrounded by a 4-inch concrete slab extending at least 2 feet in all directions and sloping away from the casing.

(c) A sanitary well seal should be installed at the top of the well casing to prevent the entrance of contaminated water or other objectionable material.

(d) For artesian aquifers, the casing should be sealed into the overlying impermeable formation so as to retain the artesian pressure.

Treatment of Well Water

There are many different treatment options for the treatment of well waters. No single treatment type will protect against all problems. Many well owners use a home water treatment unit to:

- ✓ Remove specific contaminants
- ✓ Take extra precautions because a household member has a compromised immune system
- ✓ Improve the taste of drinking water

Household water treatment systems are composed of two categories: point-of-use and point-of-entry. Point-of-entry systems are typically installed after the water meter and treat most of the water entering a residence. Point-of-use systems are systems that treat water in batches and deliver water to a tap, such as a kitchen or bathroom sink or an auxiliary faucet mounted next to a tap.

The most common types of household water treatment systems consist of:

- **Filtration Systems**

  A water filter is a device which removes impurities from water by means of a physical barrier, chemical, and/or biological process.

- **Water Softeners**

  A water softener is a device that reduces the hardness of the water. A water softener typically uses sodium or potassium ions to replace calcium and magnesium ions, the ions that create “hardness.”

- **Distillation Systems**

Distillation is a process in which impure water is boiled and the steam is collected and condensed in a separate container, leaving many of the solid contaminants behind.

- **Disinfection**

Disinfection is a physical or chemical process in which pathogenic microorganisms are deactivated or killed. Examples of chemical disinfectants are chlorine, chlorine dioxide, and ozone. Examples of physical disinfectants include ultraviolet light, electronic radiation, and heat.

- **Springs**

When groundwater makes its way to the earth's surface and emerges as small water holes or wet spots, this feature is referred to as a spring. The use of springs as the main source for community water supply is applicable whenever a spring occurs and its yield in terms of quantity and quality is sufficient. However, to maintain the water quality, protection of the spring in the catchment zone has to be ensured permanently to avoid contamination. Although springs only need little operation and maintenance, monitoring of water quality has to be conducted regularly.

Protection of the Catchment and the Spring Surrounding

In order to maintain safe drinking water quality, the permanent protection of the catchment and the direct spring surroundings is essential. The protection measures must be enforced and fully respected and understood by the local water users to guarantee long-term sustainability. Protection not only prevents the contamination of the groundwater but also improves the recharge of the aquifer.

Spring Protection

Springs are susceptible to contamination by surface water, especially during rainstorms. Contamination sources include livestock, wildlife, crop fields, forestry activities, septic systems, and fuel tanks located upslope from the spring outlet. Changes in color, taste, odor, or flow rate indicate possible contamination by surface water. To protect springs you can take the following measures.

Divert all surface water away from the spring as far as possible. Do not allow flooding near the spring.

1. Construct a U-shaped surface drainage diversion ditch or an earth berm at least 50 feet uphill form the spring to divert any surface runoff away from the spring. Be careful not to dig deep enough to uncover flowing groundwater. Prevent ponding in the diversion ditch.
2. Construct an earth berm adjacent to the spring or a second U-shaped diversion ditch lined with concrete tile for added protection.
3. Fence an area at least 100 feet in all directions around the spring box to prevent contamination by animals and people who are unaware of the spring's location.
4. Avoid heavy vehicle traffic over the uphill water bearing layer to prevent compaction that may reduce water flow.

Different types of spring protection can be constructed but in general they are as follows:

- A concrete waterproof protection box, also known as a spring box, should be constructed over the spring to prevent all actual and potential sources of contamination.
- A retention wall in the front part of the protection box should be constructed to keep water flowing to the delivery pipe. In Figure you can see the retention wall of this spring with the delivery pipe emerging from it.
- In some situations, if the flow is not constant, a collection box may also be constructed in order to ensure adequate water storage.
- The intake and overflow pipes should be screened to prevent the entrance of small animals. The spring and collection box, if there is one, should have a watertight top, preferably concrete. Water will move by gravity flow or by means of a properly-installed mechanical pump. An inspection hole should be tightly covered and kept locked.

Springs should be protected from flooding and surface water pollution by constructing a deep *diversion ditch* above and around the spring. The ditch should be constructed so it collects surface water running towards the spring and carries, or diverts, it away. It needs to be deep enough to carry all surface water away, even in a heavy rainstorm. The surrounding area should be fenced to protect it from animals (see Figure).

Figure : A protected spring. Note the concrete retention wall with two delivery pipes and the surrounding fence.

DISPOSAL OF HUMAN EXCRETA

- India is a poor sanitation country compared to the other countries, due to which it is not possible to have better water carriage system in all towns, villages and cities.
- Indian people are also not sanitary-minded due to which even in the best buildings, bathroom, bathroom and latrines are in the worst insanitary conditions.
- Generally it has been seen that people do not give any attention during the construction of bathrooms, there fore this portion of the building remains as neglected.
- The rural areas scattered localities and isplated (remote) colonies which are not served by the piped water supply, so always they have a shortage of water, due to which the quantity of water is also small, this leads to in-sanitary conditions.
- The waste, water from such areas can be easily disposed of by broad irrigation. As there is no sewer system therefore some methods should be developed for the safe collection and disposal human excreta form such areas.

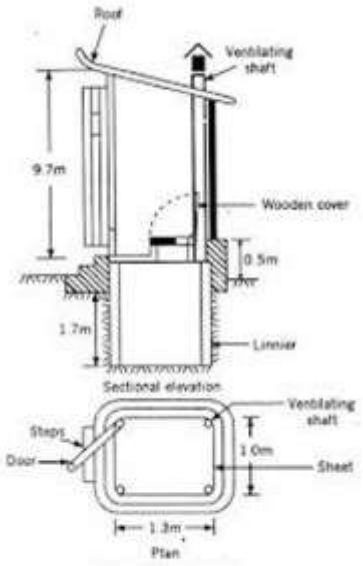
Types of privies

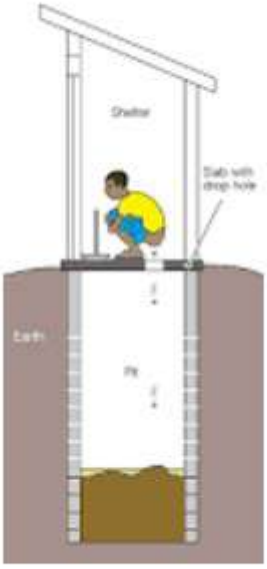
- ✓ Pit Privy
- ✓ Bore-Hole Privy
- ✓ Cesspools
- ✓ Concrete vault Privy
- ✓ Dug well Privy
- ✓ Chemical toilet
- ✓ Removable Receptacle Privy
- ✓ Aqua Privy

Pit Privy:

- ✓ This is very economical and requires no operation.
- ✓ Dimensions: 1.3X1m in plan and 1.5 to 2.8m deep.
- ✓ At the top of this pit the squatting seat is provided in a compartment.
- ✓ The super structure is of temporary in nature.
- ✓ When the pit is filled, it is closed from the top by 60cm thick earth layer and a new pit is excavated by the side of it.
- ✓ The squatting pan along with the compartment is shifted to the new trench.
- ✓ A 10cm vent pipe is also provided to take the foul gases.
- ✓ If the lime is applied frequently it will reduce the odors.

- ✓ Pit privy should be constructed 30m away from the existing well in the near by locality.





Bore-Hole Privy:

- ✓ It is similar to the pit privy, the only difference is that in place of pit, it has 40cm diameter hole.
- ✓ The depth of the bore hole should be 100 cm less than the ground water table, so that the excreta may not pollute the Ground water.
- ✓ When the hole is filled up, it is emptied and cleaned up.
- ✓ We cannot construct when the WT is very close to the ground surface.

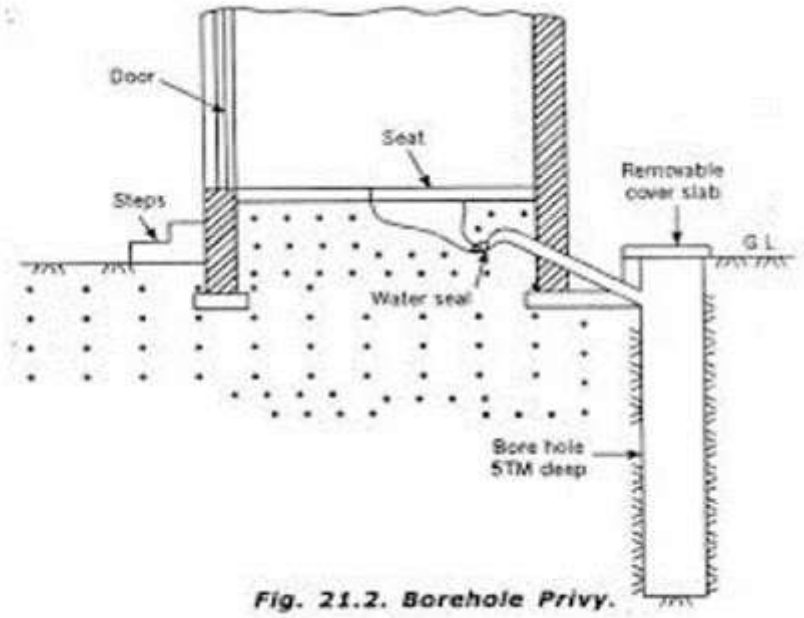
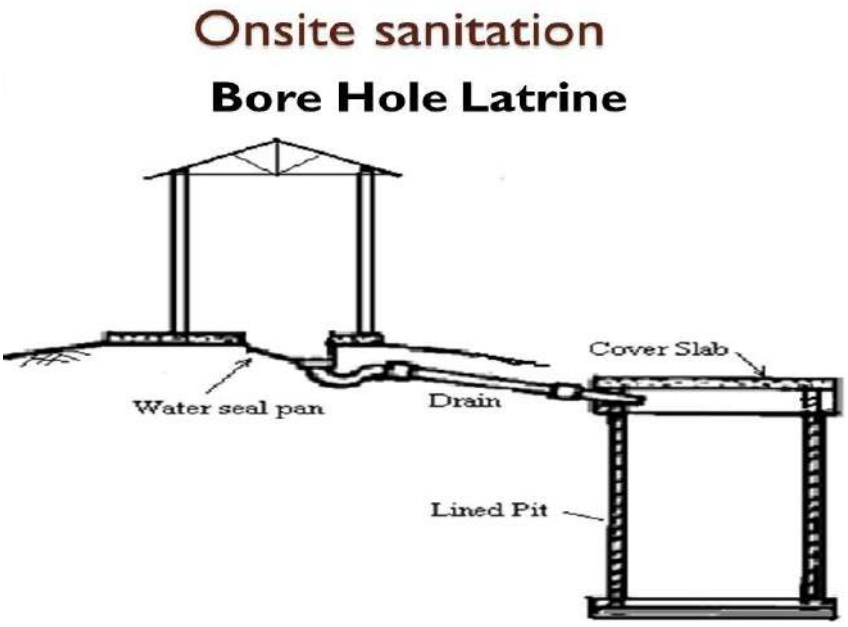


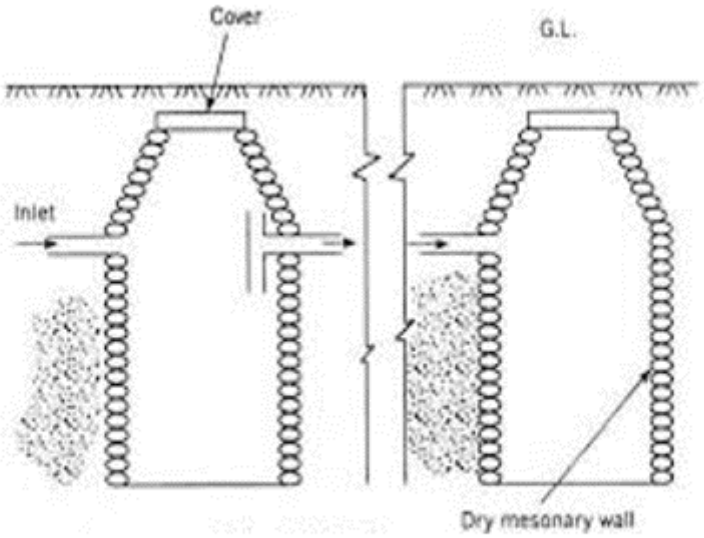
Fig. 21.2. Borehole Privy.



Cesspools:

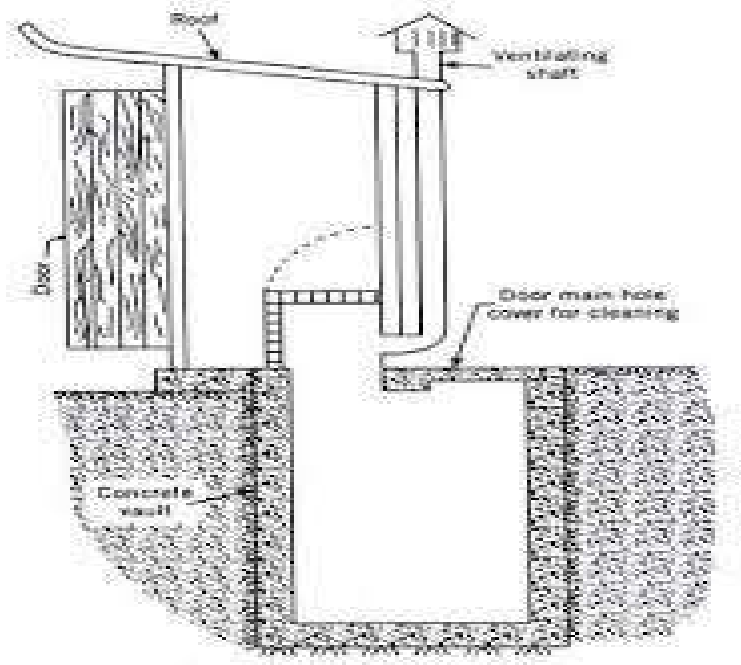
- ✓ It essentially consists of a pit or chamber lined with dry bricks or stones.
- ✓ One cesspool can serve the function of more than one building depending upon its capacity.
- ✓ The excreta matters flow through pipes from the water closets, when the cesspool is filled up, it is emptied and cleaned.

- ✓ The pumped materials are disposed of in a suitable manner.



Concrete vault privy:

- ✓ In previous soils and when water table is very close to the ground surface, it becomes difficult to construct borehole, pit or other types of privies, because the excremental matter will pollute the ground water.
- ✓ Under such circumstances concrete vault privy is most suitable.
- ✓ It is essential consists of a water tight concrete vault constructed in the ground.
- ✓ Squatting pan with compartment is placed over the concrete vault.



Dug-well privy:

- ✓ It is similar to bore hole privy only the difference is the diameter of hole.
- ✓ In Dug-well privy 75x75x360cm pit is excavated and lined with honey comb brick, to absorb the liquid waste.

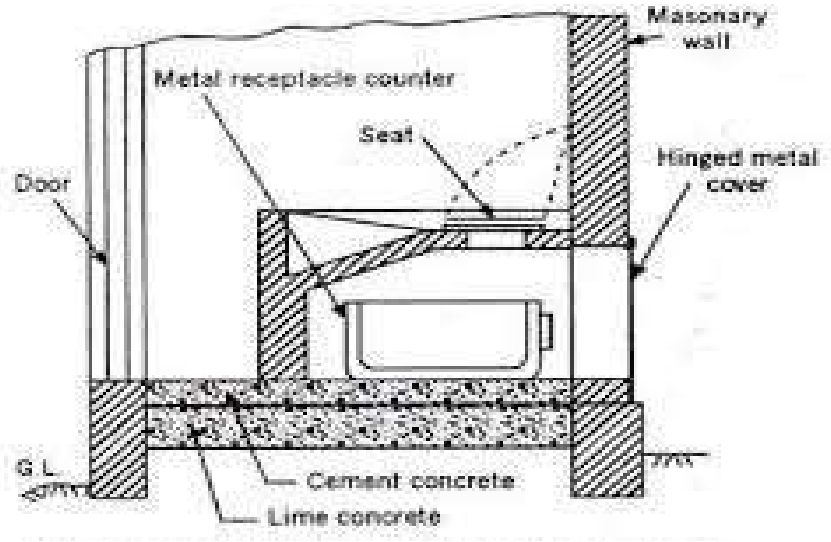
Chemical toilet:

- ✓ This the most satisfactory method of disposal of excreta with out water carriage.
- ✓ In this privy a metal tank filled with concentrated solution of caustic soda is placed below the squatting seat.

- ✓ The excreta is totally sterilized and liquefied when it comes in contact of strong caustic soda. When the metal tank is filled up, it is cleaned and emptied.
- ✓ The effluent of chemical toilet is clear and free from any odour and can be easily disposed off.

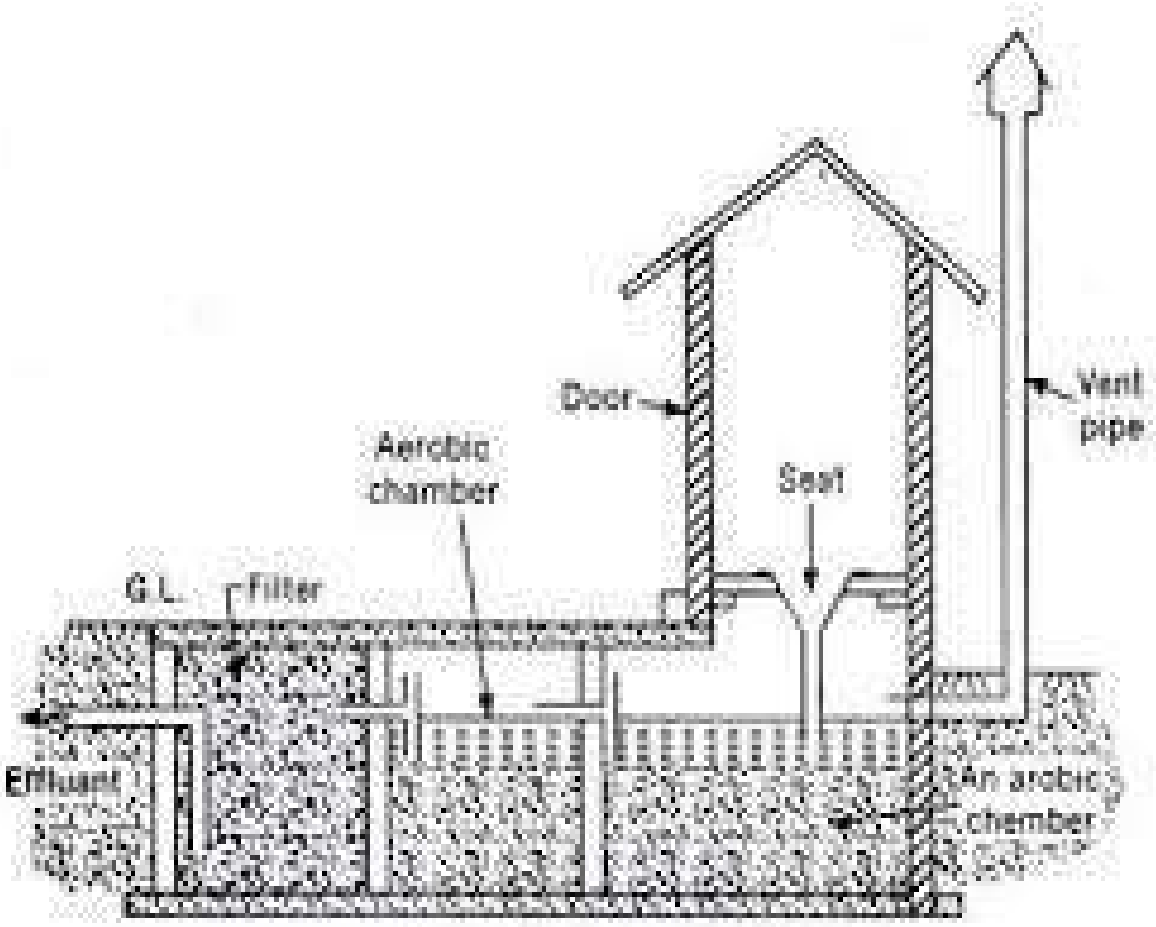
Removable Receptacle Privy:

- ✓ This is a cheap type of privy and is mostly used in India in unsewered town.
- ✓ It requires the services of sweeper for its daily cleaning.
- ✓ It essentially consists of a metal box placed below the squatting seat.
- ✓ The excreta is collected daily from this removable by sweeper.



Aqua Privy:

- ✓ Most of the privies described above are of temporary nature and shifted when the privy is tilled up with excreta.
- ✓ Therefore, they cannot be constructed as a permanent structure Aqua privy or wet latrine is an improved type of privy, which makes it possible to provide a permanent structure.
- ✓ Such types of privies are very convenient for factories villages, hilt stations etc. no doubt, they are more costly an require some attendance.
- ✓ It essentially consists of underground masonry chamber. Latrine pans enclosed inside small rooms are fixed the top of the masonry tank with the outlet ends dipped 8-10 cm in the liquid below.
- ✓ As the outlet ends of pans are dipped in water foul gases escape in the latrine rooms from the vent.
- ✓ The extra directly goes in the masonry chamber and is digested an-aerobically.
- ✓ One more chamber is also provided by the side of it, in which aerobic action takes place and the sewage is digested.
- ✓ The effluent from second chamber is allowed to pass through a filter tank.
- ✓ The final effluent is very clear and can be utilized for irrigating gardens or directly disposed of in nearby water courses.


Door
Vent pipe
Aerobic chamber
Seal
G.L.
Filter
Effluent
An arobic chamber

Environmental Sanitation

III year-I Semester

Unit-III

Refuse Sanitation

Learning Material

Refuse is all the solid and semi-solid waste matters of a community except night-soil. It can be broadly divided into two parts : (l) organic matter and (2) inorganic matter. The organic matter of the refuse is very offensive and creates health problems. it also breeds flies. the chief agents for diseases like typhoid, diarrhoea, etc. The quantity and quality of refuse depends on various factors such as season, climatic condition, geographic location, habits of people, standards of living etc. The refuse should be removed from the community as soon as possible.

QUALITY AND QUANTITY OF REFUSE

The refuse mainly consists of the following :

(a) House refuse : Ashes, cinder, rubbish, debris from cleaning and demolition of structure, vegetable and animal waste matters, etc.

(b) Street-refuse : Street sweeping, dirty materials dropped from vehicles, free leaves, empty match and cigarette boxes, fruit peels, and empty packets etc

(c) Trade-refuse: Solid wastes from factories, business centres, slaughter houses etc.

Garbage. The term "garbage" is used to designate those putres- cible wastes resulting from the growing, handling, preparation, cooking, and consumption of food. Quantities of garbage vary throughout the year, being greatest in amount during the summer months, when vegetable wastes are more abundant. The increased use of processed and packaged foods has reduced garbage production and increased the com- bustible rubbish. Garbage weighs 800 to 1,500 lb/cu yd. It requires careful handling with frequent removal and adequate disposal because it attracts and breeds flies and other insects, supplies food for rats, and rapidly ferments, resulting in the production of unpleasant odors. Garbage is probably the most valuable component of refuse in that it yields fertilizer or soil conditioner through composting processes and is utilized as hog feed.

Rubbish. The term "rubbish" denotes all nonputrescible wastes except ashes. It consists of both combustible and noncombustible substances, such as cans, paper, brush, glass, cardboard, wood, scrap metals, bedding, yard clippings, crockery, etc. Rubbish weighs 100 to 700 lb/cu yd. Before compaction it will weigh 250 to 350 lb/cu yd. Garbage and rubbish are difficult to separate entirely because those materials classed as rubbish are often used to

package food or food products, and various amounts of garbage remain attached to paper, boxes. cans. etc. Rubbish is frequently responsible lot' the creation of nuisances when it becomes scattered by the wind and careless handling.

Ashes. Ashes are the waste products of coal and other fuels which have been used for industrial purposes and in homes [or cooking and heating. Ashes weigh l. 15() to 1.400lb/cu yd. Ash production varies greatly with geographical location and, of course, with the time of year Use of natural gas and oil as fuels has greatly reduced the quality of ashes that must be collected.

Dead Animals. The problem of the removal and disposal of large dead animals, i.e., cows, horses, mules, hogs, etc., in many cities is handled by privately owned rendering plants. However, these convents do not collect small animals in most cities. and their collection is usually left to the municipal collection system. Some municipalities have solved the small-animal disposal problem by providing collection and delivery of these animals to a local rendering plant where disposal is accomplished often without charge to the city. Other satisfactory small-animal disposal methods include incineration and deep burial in specified locations,

Street Sweepings. These consist principally of materials worn from street surfaces, dirt and Other materials dropped or worn away from vehicles, leaves, sweepings from sidewalks, and bits of wastepaper Street sweepings are not usually putrescible enough to cause concern as a possible source of fly breeding or odours and may frequently be used for fill, although some dust nuisance may be created. They usually weigh 1,150 to 1,400 lb/cu yd.

Industrial Wastes. The solid wastes resulting from many manufacturing processes are often a cause for concern to public health authorities. Some wastes, if not properly handled, will produce obnoxious Odours and in the case of putrescible wastes, health hazards will be created. Most municipalities require that industrial concerns maintain their own waste collection and disposal facilities, including those for ashes and cinders, although many producers of industrial wastes arrange for the use of municipal disposal facilities.

DISPOSAL OF REFUSE

The disposal of refuse can be done by various methods. Following are common methods

of refuse disposal:

(1) by dumping into sea

(ii) by sanitary land filling,

(iii) by incineration,

(iv) by composting,

(v) by ploughing in fields.

(vi) by hog feeding.

(vii) by grinding and discharging to sewer.,

(viii) by salvaging, and

(ix) by fermentation or biological digestion.

DISPOSAL OF REFUSE BY DUMPING INTO SEA

The disposal of refuse by dumping into sea is possible only in case of coastal cities. While dumping the refuse, care is taken to take the refuse in barges, sufficient distance away (15-30 km) from the beach and dumped there. This practice is necessary to prevent the shores from refuse nuisance, because the sea waves may carry the refuse to the shores and create the nuisance. This method is not satisfactory in rough weather. Because the barges cannot be easily discharged into the sea. The refuse may be washed ashore under tidal conditions. This method is very costly and hence is not used in India.

DISPOSAL OF REFUSE BY SANITARY LAND FILLING

This is the simple effective and cheap method of refuse disposal. In this method deep trench 3-5 m deep and about 6 m wide is excavated an filed up with refuse upto depth of 2- 4 m. Now the refuse is compacted by means of suitable mechanical vehicles such as rooters or bulldozers and covered with 1-2 m earth. With the time, the earth fill may settle 10-30%. The micro-organisms slowly start the decomposition of the organic matters of refuse, and convert them into stable compounds. This decomposition is similar to that in composting and is mostly brought out by facultative bacteria and fungi. Facultative bacteria under anaerobic conditions hydrolyze the complex organic matter into simpler water-soluble organic acids, which diffuse through the soil, where fungi and the other types of bacteria are decomposing the organic matter into carbon di-oxide and water under aerobic conditions. In some cases, the methane bacteria build up with the discharge of methane through the soil.

DISPOSAL BY REFUSE BY INCINERATION

This is the best method of disposal of combustible refuse. In this method, the combustible refuse is burnt. All sorts of bacterias, insects etc., are destroyed and the remaining ashes, metals etc., have little sanitation problems. The produced during the burning of the refuse can be utilized for production of steam and other purposes. High construction and operation costs have limited the wide application of incinerators by the local bodies. In large, crowdy cities, where sites for land filling are not available incineration plants be constructed for disposal of refuse. Mechanized salvageable material can further reduce the overall cost of incineration.

DISPOSAL OF REFUSE BY COMPOSTING

This method of disposal is very Similar land filling,but it yields a stable end product early due to controlled microbial reaction, From the refuse, decomposed organic matter isseparated and composted to produce a stable matter, which is used for reclaiming waste landor growing

crops. The method of refuse disposal by composition is popular in india and other more populated countries.

In India two methods viz. (l) Indore Method, and (2) Bangalore Method are commonly used. In the Indore method, 3 x 3 x I m shallow brick pits are constructed. Refuse and night soil are placed alternatively in layers of 7.5 to 10 thick up to 1.5 m height. For preventing fly-breeding chemicals are added. Up to 8-12 weeks, the materials are turned regularly and then stored on ground for a period of 4-6 weeks. In 6-8 turnings and about 4 months time, the compost become ready for use. In the Bangalore method, earthen trenches 10 x 1.5 x 1.5m are filled up in alternate layers of refuse and night soil/cowdung. The material is covered with 1.5 cm layer of earth and left for decomposting. After 4-5 months the compost become ready for use. The Indore method is primarily aerobic in nature, where as the Bangalore method is primarily anaerobic in nature. A town having population of 50,000 person will produce about 10,000 tonnes of refuse and 4000 tonnes night soil annually. The compost plant will produce about 9000 tonnes of compost annually from the above sewage and night soil. In the larger compost plant the cost or production or compost in large plants is about Rs. 8 per tonne. which is very cheap as compared with fertilizers.

DISPOSAL OF REFUSE BY PLOUGHING IN FIELDS

This is uncommon method of disposal of refuse on large scale. The refuse of summer camps such as school camps, N.C.C. camps. etc., this method is used. As the quantity of refuse is very small, it is disposed off in the fields which is later on ploughed by the farmers.

DISPOSAL OF REFUSE BY HOG FEEDING

In this method the garbage is fed to the animals like hog, swings etc. In western countries and America this method is very common. Garbage is the main element of refuse, which is difficult to handle in sanitary conditions. It is responsible for disease and health hazards. But the raw feeding of garbage to the animals. is responsible for diseases or vesicular exanthema in swinges and cholera among hogs. In foreign countries the health authorities recommended heating of garbage up to 100 degree C for 30 minutes as precaution got killing the disease bacterias.

DISPOSAL OF REFUSE BY GRINDER AND DISCHARGING TO SEWER

This method is not common in India, but is used in America and other western countries. In this method, the refuse is well grindéd in house or commercial grinders and is discharged in the sewer. This method leaves the problem of disposal of residual refuse 85-90% as unsolved, because it is mixed in the sewage. By discharging the garbage into sewers, the B.O.D. and suspended solids are increased by 20-25% and 25-35% respectively.

DISPOSAL OF REFUSE BY SALVAGING

This method is not practised by the local bodies or municipalities. Usually the labours of salvage dealers collects the paper, metals, glass, rags, plastic cotton pieces etc., from the dust bins/refuse bins-placed along the roads. If proper care is taken to store the salvaged materials

pending their utilization, some income can be made out of them, as well as helping in the disposal of the refuse.

DISPOSAL OF REFUSE BY FERMENTATION OR BIOLOGICAL DIGESTION

In this method the garbage is placed in air tight seared tanks. without air for 10 days and then in presence of air for 15-20 days. In this method if required the drainage collected at the bottom of the tank may be recirculated for keeping the garbage waste for proper biological digestion. The digested refuse/garbage is table and can be used as soil conditioner.

Environmental Sanitation

III Year – I Semester

Unit-IV

Food Hygiene and Sanitation

Learning Material

Milk:

Milk is important food which may easily become a source for spreading microbial infection because it is good bacteria multiplier. Milk contains 3% proteins, 4% butter fat and 5% lactose. which are responsible for microbial growth. Micro-organisms may come in the milk from air, milk containers, the cow and from the persons handling the milk. Therefore it is necessary that milk should be taken from healthy cows, should be kept in sanitary containers and handled by healthy persons. Before drinking or using for Other purposes, the milk should be boiled for 10 minutes to kill micro-organisms if any.

Milk should be prevented from all possible infections. The milking cows should be healthy, free from disease. The workmen working in dairy should also be clean, and healthy, free from communicable diseases. The cow born should also be clean airy and dustless with sanitary cow yard and surroundings. The milk room should be constructed separately. properly screened milk and pure water should be stored in the milk room. Dairy utensils and equipments should be properly designed. Cans, pails, coolers, bottles and other equipments should be properly sterilized before they come in contact or milk. In diary raw milk should not be stored for longer lime. Milking, bottling, capping and milk delivery should be very prompt. For saving milk and controlling infection, refrigeration should be done. It has been noted that no undesirable taste is developed in the milk. Refrigeration of milk reduces the growth of bacteria and keep the quality of milk for longer time. As far as possible the milk should be kept in refrigeration all the time before consumption.

Milk Products. Under the Public Health Service Milk Ordinance, milk products include cream, sour cream, half and half, reconstituted half and half, whipped cream, concentrated milk, concentrated- milk products, nonfat milk, flavored milk, flavored reconstituted milk, cultured buttermilk, cultured milk, cottage cheese, creamed cottage cheese, homogenized milk, goat milk, vitamin D milk, buttermilk, skim milk, reconstituted or

recombined milk, milk beverages, and any other product designated as a milk product by the health officer. Some of the above terms may require definition. Homogenized milk is milk which has had its fat globules broken up to such an extent that no visible cream separation occurs on the milk within 48 hr of storage and in which the top 100 ml of a quart bottle (or proportionate amount in another container) differs no more than 10 per cent of itself in fat percentage from that of the remaining milk, as determined after thorough mixing of each portion. The Milk Ordinance and Code prohibits the mixing of homogenized milk or cream with unhomogenized milk or cream. This "partial homogenization" has been practiced by some milk plants to increase the apparent butterfat content when the milk is viewed in a bottle, for the homogenized material would come to the top. Vitamin D milk is that which has had its natural vitamin D content increased by an approved method to at least 400 USP units per quaft. Reconstituted or recombined milk results from recombining milk constituents with water so that it will comply with the requirements as to butterfat and solids- not-fat. Reconstituted or recombined cream results from the combination of dried cream, butter, or butterfat with cream, skim milk, or water. Milk products, as defined above, should be controlled and graded in the same manner as milk. As mentioned previously, however, bacterial standards differ in the case of cream, where designated counts are doubled, and in the case of sour cream, buttermilk, and cottage cheese, where they are omitted entirely.

Dry Milk and Dry-milk Products: Dry milk and dry-milk productS are widely used, and the Public Health Service has prepared a sanitation ordinance and code to control their sanitary quality [18]. This ordinance requires that the milk used for drying comply with requirements for Grade A raw milk for pasteurization as defined in the Milk Ordinance and that the milk be pasteurized at the drying plant. After Pasteurization such milk and milk products shall at no time have a bacterial plate count or direct microscopic clump count exceeding 30.000 per milliliter, although these counts may be increased in of concentrated products in proportion to the degree of concentration Grade A dry-milk products must have a bacterial plate count not exceeding 30,000 per gram and a coliform count not exceeding 90 pergram

Butter is a dairy product with high butterfat content which is solid when chilled and at room temperature in some regions, and liquid when warmed. It is made by churning fresh or fermented cream or milk to separate the butterfat from the buttermilk. It is generally used as a spread on plain or toasted bread products and a condiment on cooked vegetables, as well as in

cooking, such as baking, sauce making, and pan frying. Butter consists of butterfat, milk proteins and water, and often added salt.

Most frequently made from cow's milk, butter can also be manufactured from the milk of other mammals, including sheep, goats, buffalo, and yaks. Salt (such as dairy salt), flavorings (such as garlic) and preservatives are sometimes added to butter. Rendering butter, removing the water and milk solids, produces clarified butter or *ghee*, which is almost entirely butterfat.

Butter is a water-in-oil emulsion resulting from an inversion of the cream, where the milk proteins are the emulsifiers. Butter remains a firm solid when refrigerated, but softens to a spreadable consistency at room temperature, and melts to a thin liquid consistency at 32 to 35 °C (90 to 95 °F). The density of butter is 911 grams per Litre (0.950 lb per US pint).[1] It generally has a pale yellow color, but varies from deep yellow to nearly white.

Cheese is a dairy product derived from milk that is produced in a wide range of flavors, textures, and forms by coagulation of the milk protein casein. It comprises proteins and fat from milk, usually the milk of cows, buffalo, goats, or sheep. During production, the milk is usually acidified, and adding the enzyme rennet causes coagulation. The solids are separated and pressed into final form.[1] Some cheeses have molds on the rind, the outer layer, or throughout. Most cheeses melt at cooking temperature.

Over a thousand types of cheese from various countries are produced. Their styles, textures and flavors depend on the origin of the milk (including the animal's diet), whether they have been pasteurized, the butterfat content, the bacteria and mold, the processing, and aging. Herbs, spices, or wood smoke may be used as flavoring agents. The yellow to red color of many cheeses, such as Red Leicester, is produced by adding annatto. Other ingredients may be added to some cheeses, such as black pepper, garlic, chives or cranberries.

Custard is a variety of culinary preparations based on milk or cream cooked with egg yolk to thicken it, and sometimes also flour, corn starch, or gelatin. Depending on the recipe, custard may vary in consistency from a thin pouring sauce (*crème anglaise*) to the thick pastry cream (*crème pâtissière*) used to fill éclairs. The most common custards are used in desserts or dessert sauces and typically include sugar and vanilla, however savory custards are also found, *e.g.* in quiche.

Custard is usually cooked in a double boiler (bain-marie), or heated very gently in a saucepan on a stove, though custard can also be steamed, baked

in the oven with or without a water bath, or even cooked in a pressure cooker. Custard preparation is a delicate operation, because a temperature increase of 3–6 °C (5–10 °F) leads to overcooking and curdling. Generally, a fully cooked custard should not exceed 80 °C (~175 °F); it begins setting at 70 °C (~160 °F).[1] A water bath slows heat transfer and makes it easier to remove the custard from the oven before it curdles.[2] Adding a small amount of cornflour to the egg-sugar mixture stabilises the resulting custard, allowing it to be cooked in a single pan as well as in a double-boiler. A sous-vide water bath may be used to precisely control temperature.

Ice cream (derived from earlier **iced cream** or **cream ice** is a sweetened frozen food typically eaten as a snack or dessert. It may be made from dairy milk or cream and is flavored with a sweetener, either sugar or an alternative, and any spice, such as cocoa or vanilla. Colourings are usually added, in addition to stabilizers. The mixture is stirred to incorporate air spaces and cooled below the freezing point of water to prevent detectable ice crystals from forming. The result is a smooth, semi-solid foam that is solid at very low temperatures (below 2 °C or 35 °F). It becomes more malleable as its temperature increases. Vegan ice cream-substitutes can be made using soy, cashew, coconut or almond milk.

The meaning of the name "ice cream" varies from one country to another. Terms such as "frozen custard," "frozen yogurt," "sorbet," "gelato," and others are used to distinguish different varieties and styles. In some countries, such as the United States, "ice cream" applies only to a specific variety, and most governments regulate the commercial use of the various terms according to the relative quantities of the main ingredients, notably the amount of cream.[2] Products that do not meet the criteria to be called ice cream are sometimes labelled "frozen dessert" instead.[3] In other countries, such as Italy and Argentina, one word is used for all variants. Analogues made from dairy alternatives, such as goat's or sheep's milk, or milk substitutes (e.g., soy milk or tofu), are available for those who are lactose intolerant, allergic to dairy protein, or vegan.

Ice cream may be served in dishes, for eating with a spoon, or licked from edible cones. Ice cream may be served with other desserts, such as apple pie, or as an ingredient in ice cream floats, sundaes, milkshakes, ice cream cakes and even baked items, such as Baked Alaska.

Sanitary Maintenance of Catering

The sanitary microbiologists are mainly concerned with the prevention Of the spread Of diseases rather than the preservation of food. Following are the main five agencies, which are responsible for the public health

i. Preservative poisons used for the preservation of food, colouring, adulterations etc., and insect poisons, poisonous spray residues left on eatables etc ;

ii. Poisonous plants or other food materials which may enter into human body by eating ;

iii. Animal parasites like tapeworms, trichina etc., which can enter in the human body by eating infected meat or fish :

iv. Tuberculosis or typhoid bacilli bacteria present in the infected milk and organisms of salmonella group, which may cause food poisoning or food infection.

v. Toxins given off by bacteria like botulinus organism and some staphylococci, which grow in the foods.

Sanitary Maintenance of eating and drinking Establishments

The public eating and drinking establishments may transmit diseases by utensils. If the utensils are not properly cleaned (which are usual), it will transmit respiratory and intestinal infections. Flies and contaminated water are also the source of diseases. Large number of people who take their food mostly in restaurants and hotelseach day form a reservoir for the spread of diseases.

Sanitary inspectors should regularly inspect the eating and drinking and ensure that sanitary measures and regulations are followed strictly. As improper cleaning of utensils leaves a thin organic film on them, which serves as breeding place for bacterias. Therefore, all the utensils should be completely cleaned and disinfected. The utensil-washing process should include elimination of large food particles into garbage cans, pre-rinsing removing small food particles, washing in water at 40deg — 450 deg mixed with soap detergents such as quarter-nary ammonia compound and finally rinsing combined effective germicidal process with chlorine compounds etc. After washing the dishes be drains dried and should not be wiped with a towel

In addition to the proper cleaning process of washing utensils, the public eating establishments should have high quality flows, walls, ceiling, screened doors and windows. They should have fly repelling fans, elaborate ventilation and lighting ; separate rooms for employees and food handlers, clean dresses of employers; clean employees; separate room for receptacles for soiled man. The food materials should be obtained from the sanitary sources, approved by the sanitary department. All efforts should be made to supply germs free bacteria free food and drinks to the public. All such public places should be kept in sanitation conditions all the times.

Sanitary requirements and Maintenance for school

- School hygiene and sanitation are especially important because children spend a great deal of time at school and they need a healthy environment to learn, and grow, physically, mentally and socially.
- Sanitary inspection of public institutions is a method for identifying hygiene and sanitation problems

Health-related policies in schools

- All schools should be aware of the importance of school hygiene and sanitation for their students.
- Promotion of hygiene, organising hygiene/health clubs, having a clean school compound and supervising classrooms for their cleanliness are some of the items that require the attention of the school authorities.
- The implementation of policy statements must take into account the availability of human resources and materials.

Classroom sanitation

- The cleanliness of the classroom is vital for a good learning process.
- Students should be involved in the maintenance of classroom cleanliness on a daily basis.
- The floor of the classroom should be smooth to reduce dust.
- Dust and cracks in the floor must be avoided because these are good hiding sites for biting animals such as the ant, bookworm etc.

Classroom sanitation: smooth floor, physical suitability of seats and desks, and adequate light and ventilation. (Photo: AberaKumie)

Components of Personal Hygiene are Most Important to Students

- ✓ Keeping the body clean,
- ✓ face and handwashing,
- ✓ wearing clean clothes,
- ✓ Food preparation, and
- ✓ nail care

Healthy school environment

The important aspects of a safe and healthful school environment are:

- ➢ Adequate classroom space to avoid crowding. The Ministry of Health recommends: 2 m^2 per student at kindergartens; 1.11 m^2 per student at primary school; 1.26 m^2 per student at secondary schools.
- ➢ Classrooms with adequate daylight and ventilation; the proportion of window to floor area should be 25%.
- ➢ Classrooms that protect students vision through the appropriate distance between the blackboard and the first line of seats.
- ➢ Dimensions of desks and chairs that match the students physical development.

- The location of the school should be free from any potential physical and chemical hazards (e.g. free from noise and air pollution).
- Playing areas for physical exercise.

Schools & Educational institutions

Sl. No.	Fitments	Nursery schools	Educational institutions (non-residential)		Educational institutions (residential)	
			For boys	For girls	For boys	For girls
1.	Water closets	1 per 15 pupils	1 per 40 pupils	1 per 25 pupils	1 for 8 pupils	1 for every 6 pupils
2.	Ablution taps	1 in each W.C.	1 in each W.C.	1 in each W.C.	1 in each W.C.	1 in each W.C.
3.	Urinals		1 per 20 pupils		1 for every 25 pupils	
4.	Wash basins	1 for 15 pupils	1 per 60	1 per 40	1 for every 8 pupils	1 for every 6 pupils
5.	Baths	1 for 15 pupils			1 for every 8 pupils	1 for every 6 pupils
6.	Drinking water fountains	1 for every 50 pupils	1 for every 50 pupils	1 for every 50 pupils	1 for every 50 pupils	1 for every 50 pupils
7.	Cleaner's sink	1 per floor, minimum				

Sanitary requirements and Maintenance for Hospitals

- When people talk about sanitation in a hospital, they are speaking about the procedures used to maintain a stringently clean and safe place for patients and staff.
- A hospital sanitation worker must ensure that cleanliness is upheld at all times and that all codes of conduct are satisfied.
- Hand hygiene is a great way to prevent infections. Even healthcare providers are at risk of getting an infection while they are treating patients. Preventing the spread of germs is especially important in hospitals and other facilities such as dialysis centers and nursing homes.
- Cleanliness is crucial in healthcare settings. Controlling the spread of infections or viruses is vitally important in many different locations and settings – such as schools, leisure centres and the workplace – but it is even more crucial for healthcare providers.

Office buildings

Sl. No	Fitments	For Male Personnel	For Female Personnel
1.	Water-closets	1for every 25 persons	1 for every 15 persons
2.	Ablution taps	1 in each water-closet	1 in each water-closet
3.	Urinals	• Nil, upto 6 persons • 1 for 7-20 persons • 2 for 21-45 persons • 3 for 46-70 persons • 4 for 71-100 persons • From 101-200 persons add at the rate of 3% • For over 200 persons add at the rate of 2.5%	
4.	Wash basins	1 for every 25 persons	
5.	Drinking water fountains	1 for every 100 persons with minimum 1 on each floor	
6.	Cleaner's sinks	1 per floor, preferably near sanitary room	

Cinemas, concert halls, and theatres

Sl. No.	Fitments	For male public	For female public	For male staff	For female staff
1.	Water-closets	1 per 100 persons upto 400 persons. Add dt the rate of 1 per 250 persons	•3 per 100 persons upto 200 persons. For over 200 persons. • Add at the rate of 2 per 100 persons	• 1 for 1-15 persons • 2 for 16-35 persons	• 1 for 1-12 persons • 2 for 13-25 persons
2.	Ablution taps	1 in each water closet	1 in each water closet	1 in each water closet	1 in each water closet
3.	Urinals	1 for 25 persons or part thereof		•Nil for 1-6 • 1 for 7-20 • 2 for 21-45	
4.	Wash basins	1 for every 200 persons	1 for every 200 persons	• 1 for 1-15 • 2 for 16-35	• 1 for 1-12 • 2 for 13-25
5.	Drinking water fountain	1 for every 100 persons o part thereof			

ENVIRONMENTAL SANITATION

III Year – I Semester

Unit-V

Ventilation, Air Conditioning and Light

Learning Material

Air Pollution: Air pollution may be defined as the presence of impurities in excessive quantity and duration to cause adverse effects on plants, animals, human beings and materials.

Every day man breaths nearly about 15 to 22 kg of air. The air is available abundantly on the earth and it contains oxygen, carbon dioxide, nitrogen and small amount of other gases which are harmless to us. However, it also contains substances that are harmful like sulphur-dioxide, carbon monoxide, nitrogen oxide, sulphur oxide, hydrocarbons, dust, smoke and other suspended matter. Every time we inhale, we carry dangerous air pollutants in to our bodies. These pollutants can cause short-term effects as well as long-term effects to the human beings.

The air pollutants enter in to the atmosphere from various natural and man-made activities such as forests, fires, volcanic eruptions, dust storms, rapid growth of industries and vehicles. Polluted air causes physical ill-effects, besides undesirable aesthetic and physiological effects.

Air pollution from automobiles, industrial plants, coal burning, power plants have created serious environmental pollution problems.

Sources of Air Pollution: The two main sources of air pollution are

a. Natural sources

b. Man-made (or) anthropogenic sources

Natural sources include dust storms, volcanoes, sea salt, smoke, forest fires etc. The man-made sources are agricultural activities, industrial growth, domestic wastes, automobile exhausts etc.

Types of Air Pollutants:

Air pollutants are generally grouped in to the following two types

a. Particulate pollutants

b. Gaseous pollutants

a. Particulate Pollutants: In general the term “particulate” refers to all atmospheric substances that are not gases. They can be suspended droplets (or) solid particles or mixtures of the two particulates can be composed of

materials ranging in size from 100µm down to 0.1µm and less. The chemicals composition of the particulate pollutants is very much dependent upon the origin of the particulate.

Dust, smoke, fumes, mist, fog, aerosol are the classification of particulates.

Suspended particulate matter (SPM) is a complex mixture of small and large particles with size less than 100µ varying origin and chemical composition.

The particulate matters generated by natural sources are much greater than that from anthropogenic sources.

Dust: Dust contains particles of size ranging from 1 to 200 µm. These are formed by natural disintegration of rock and soil. They vary in size and shape and are not uniformly diffusible. They teng to gravitate and those less than 5u in size reach the lungs. Eg:- coal, wheat flour, magnesium, aluminium, silica.

Fumes: Fumes are solid particles formed by condensation from gaseous state. They are less than 1µ size and come from molten metals. Eg:- lead, cadmium particles of the size ranging from 0.1 to 1 µm.

Smoke: Smoke is formed from incomplete combustion of organic matter. Smoke may have different colours depending on the nature of material burnt. It contains fine particles of the size ranging from 0.01 to 0.1 µm.

Mist: Mist is made up of liquid droplets generally smaller than 10 µm which are formed by condensation in the atmosphere are released from industrial operations.

Fog: Fog is similar to mist but the droplet size bigger (> 10 µ) and water is liquid.

Bacteria: These are particulate and sub microscopic.

b. Gaseous pollutants: These are toxic and poisonous gases such as carbon monoxide, chlorine, ammonia, hydrogen sulphate, sulphur dioxide, nitrogen oxides and carbon dioxide.

They are formed during various industrial operation

i. carbon monoxide (CO):- carbon monoxide is a colourless, odourless, invisible and poisonous gas. It is produced by the incomplete burning of carbon in fuels, cigarette, and smoke. Major sources include wood stoves, automobile exhaust and other industrial sources. CO pollution comes from the man-made sources 400 million ton of CO is emitted from natural sources.

ii.Sulphur dioxide (SO_2):- Coals contain a significant burning of coal, diesel fuel in industries like steel mills, paper and pulp mills. It is not possible to

remove sulphur from the coal, oil and diesel before burning Approximately 200 million tons of so_2 are generated annually from natural sources.

iii. Nitrogen oxides (NO_x):- oxides of nitrogen are originated from both natural and anthropogenic sources among the nitrogen oxides, nitrogen dioxide pollution is contributed by anthropogenic sources. Among the sources about 65% of NOx is emitted from automobiles 25% is from burning of coal and 10% is from the use of natural gas.

iv. Lead: lead pollution has been reduced significantly since leaded gasoline was banned several years ago. But still exists caused by the lead smelters, burning of the lead batteries.

Air Pollution due to Industries:

Many air pollutants are dispersed over areas hundreds of kilometres from their sources where they affect many different ecosystems.

S. No	Type of Industry	Origin of emission	Pollutants emitted
1	Chemical and metallurgical industry	Heating of lead, zinc and copper ores	SO_x, NO_x, CO, dust, fumes
2	Chemical process industries	Raw material processing and reaction products	SO_2, NH_3, NO_2, hydrogen fluoxide, Hcl, H_2O
3	Iron & steel industry	High temperature processing of coal and iron ore	CO, CO_2, lead, dust, H_2S, hydrocarbons and SO_2
4	Food and agricultural industries	Food processing crop spraying and dusting	Vapours, odour, dust, lead etc
5	Pulp & paper industry	Combustion of wood	H_2S, odour, particulate matter
6	Thermal power station	Burning of coal	Flyash, SO_2

Air Pollution due to Vehicles:

The automobiles are one of the major sources of air pollution and they produce almost one-third of all air-pollutants. One of the main cause is exhaust fumes from automobiles that run on gasoline and diesel. The principal pollutants emitted from burning of fuel from automobiles are carbon monoxide, nitrogen oxides and hydro carbons which are known to be toxic to human health and damaging to the environment.

The petrol and diesel engines emit similar type of pollutants but their proportions are varied due to difference in the mode of operation of these two types of engines.

Effects of Air Pollution:

The effects of air pollution are listed below

i. effect of air pollution on human health

ii. effect of air pollution on plants

iii. effect of air pollution on properties of atmosphere

iv. effect of air pollution on animals

Effect of air pollution on animals: Animals take up fluorides of air through plants. Their milk production falls and their teeth and bones are effected. They are also prone to lead poisoning and paralysis.

Effect of air pollution on properties of atmosphere: Some of the effects of air pollution on the physical properties of atmosphere are

i. Decrease in the visibility

ii. Reduction of solar radiation

iii. Effects on weather condition

iv. Effects on atmospheric constituents

Impact of Air Pollution on health: Air pollution is a major factor in causing human to get ill. Heart and chest diseases, stomach disorders, asthama and cancer are caused due to chemicals present in the air.

Ambient: - Usual (or) surrounding environmental condition.

Ambient air: - Any unconfined portion of the atmosphere, open air, surrounding air.

Bacteria in Air:

- ✓ It is supposed that bacteria are not suspended in the air alone but are carried by particles like dust, organic matter.
- ✓ Street dust may contain 50 million bacteria per gram.
- ✓ Indoor dust up to 5 million per gram.
- ✓ Except during high wind outdoors and dry sweeping indoors, little of the dust gets in to the air.
- ✓ Bacteria is discharged in to the air during coughing, sneezing, and talking.

Organic matter and Odors:

- The odors which can sometimes be detected in crowded or poorly ventilated rooms are due to perspiration mingled with organic compounds from skin and clothing and also decomposition taking place in mouth.
- They must be prevented by an addition of fresh air sufficient to keep down the concentration of organic matter.
- These noticeable body odors were formerly supposed to be the cause of diseases.

Ventilation and Air-Conditioning

Ventilation: Ventilation may be defined as supply of fresh outside air in to a enclosed space or the removal of inside air from the enclosed space. In the other words, ventilation is the removal of all vitiated air from a building and its replacement with fresh air ventilation may be achieved either by natural or by artificial (or mechanical).

Ventilation is necessary for the following reasons:

i. creation of air movements.

ii. Prevention of undue accumulation of carbon dioxide.

iii. Prevention of flammable concentration of gas vapour.

iv. Prevention of accumulation of dust and bacteria carrying particles.

v. prevention of odour caused by decomposition of building materials.

vi. Removal of smoke, odour and foul smell generated/ liberated by the occupants.

vii. Removal of heat generated / liberated by the occupants.

viii. Prevention of suffocation conditions in conference room, committee halls, cinema hall, big rooms etc.

Functional requirements of ventilation system:

From the point of view of human comfort, ventilation system should meet the following functional requirements

i. Air changes or Air movement

ii. Humidity

iii. Quality of air

iv. Temperature

i. Air Changes: In an enclosed space, where people are working or living, air has to moved or changed to cause proper ventilation. The minimum rate of air change is one per hour, while the maximum rate of air change is sixty per hour. Air change per hour is the volume of outside air allowed in the room or enclosed space per hour compared to the volume of air. If the rate of air change is less than one per hour, there will be no ventilation. While if the rate of air change is more than sixty per hour it will cause discomfort to the occupants because of high velocity of air.

ii.Humidity: Air contains certain amount of water vapour in it. Relative humidity is defined as the ratio of amount of water vapour present in the air to the amount of water vapour if the air was saturated at the same temperature.

iii. Quality of Air: The ventilating air should be free from impurities, odours, organic matter and inorganic dust. It should also be free from unhealthy fumes of gases such as carbon monoxide, carbon dioxide, sulphur dioxide etc. The ventilating air should not come from the chimneys, kitchens, urinals etc.

iv. Temperature: It is desirable that the incoming ventilating air should be cool in summer and warm in winter, before it enters the room. The general temperature difference between inside and outside kept not more than 8°c.

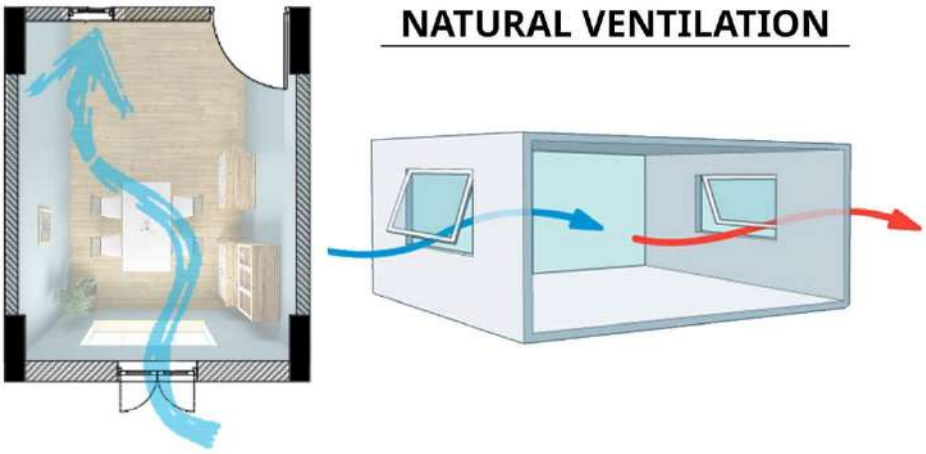
Systems of Ventilation:

Systems of ventilation may be divided in to two categories

i. Natural Ventilation

ii. Mechanical (or) artificial ventilation

i. Natural Ventilation: Natural ventilation is the one in which ventilation is effected by doors, windows, ventilators and skylights and other openings in the enclosed space. It is usually considered suitable for residential buildings and small buildings. However it is not useful for big buildings, offices, conferences, halls, auditoriums, large factories etc. It is economical since no equipment is required for keeping the room ventilated.



ii.Mechanical Ventilation: Mechanical ventilation is the one in which some mechanical arrangements are made to increase the rate of air flow. The system is more useful for large buildings, assembly halls, factories, theatres etc. Though the system is more costly it results in consideration efficiency of the persons using the building.

There are following systems of artificial ventilation

i. Extraction system

ii. Plenum system

iii. Extraction-plenum system

iv. Air-conditioning

i. Extraction System (or) Exhaust System: This system is based on creation of vacuum in the room by exhausting the vitiated inside air by means of propeller type fans (exhaust fans). Air inlets are formed at a height of 1.2 to 1.8m through tobin tubes, and the outlet is arrangement with in a quarter of a meter of ceiling on the opposite side of the room from which air enters. The extraction of air from the room permits the fresh air to flow from outside to inside either through tobin tubes or even through a window. This system is more useful in removing smoke, dust, odours etc from kitchen, laterines, industrial plants etc.

ii. Plenum System (or) Supply System: In this system, fresh air is forced in to the room and the vitiated air is allowed to leave through ventilators. The air inlet is selected on that side of the building where purest air is available. The incoming air which is mechanically forced in the room is passed through a fine gauge screen (or) filter. A constant stream of water is kept flowing down the screen giving a fine mist of water through which the air is drawn by means of blowers fan. Thus, all the mechanical impurities are removed from the air. In summer this also results in cooling of air. This ventilation system is costly but it is used for factories, conference halls, theatres, big offices etc.

iii. Extraction-Plenum System: This is an extension of plenum system in which extraction fans are used for the exit of the vitiated air from the room. It is used for kitchens, laterines or various manufacturing process.

iv. Air-Conditioning: This is the best system of artificial ventilation in which provision is made for filtration, heating or cooling, humidifying or dehumidifying etc. Thus creating most comfortable working condition.

Air-Conditioning:

Air conditioning may be defined as the process of treating air so as to control simultaneously its temperature, humidity, purity and distribution to meet the requirements of the conditioned space. The various requirements of a conditioned space may be comfort and health of human beings, needs of certain industrial process, efficient working of commercial premises etc.

Air Conditioning is resorted to for the following

i. It helps in preserving or maintaining health, comfort and convenience of occupants of residential building.

ii. It helps in improving the quality of products in certain industrial processes such as artificial silk, cotton cloth etc.

In other cases of industries it provide comfortable working conditions for the workers, resulting in the increase of the production.

iii. It helps in marketing the commercial premises such as shops, banks, offices, restaurants etc for more active and efficient.

iv. It provides more comfortable entertainment in theatres etc.

v. In the case of air conditioned railway/road way coaches or air travel journey becomes more comfortable.

Classification based on season/ temperature:

(a) Summer air Conditioning: In summer, outside temperature is more and hence cooling of air is required for greater comfort. The cycle of operation consists of (i) air cleaning (ii) air cooling (iii) dehumidification (iv)air distribution/circulation.

(b) Winter air conditioning: In winter outside temperature is low and hence heating of air is required for comfort. The cycle of operation consists of (i) air cleaning (ii) air heating (iii) humidification and (iv) air distribution/circulation.

(c) Composite air conditioning: In this the same air conditioning is done throughout the year, irrespective of outside temperature.

Systems of Air Conditioning:

All air conditioning systems can be broadly classified in to two categories

(a) Direct Expansion (DX) System

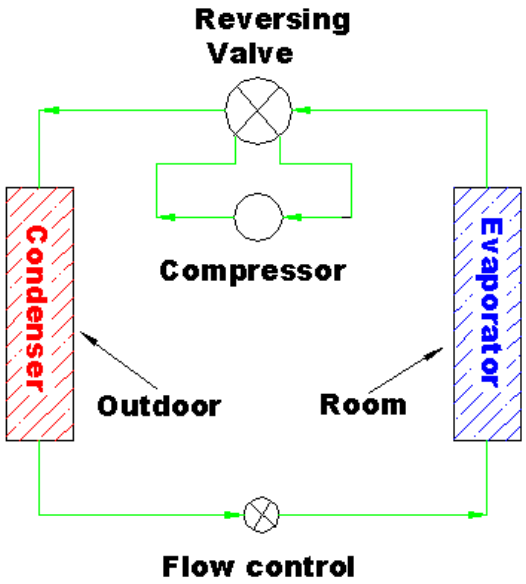
(b) Chilled Water (Indirect) System

(a) Direct Expansion (DX) System: It is the system where the refrigerant is utilised to cool the air directly. The common examples of the system are

i. Room air conditioner

ii. Packaged units

iii. Central-direct expansion plants



The main components of the direct expansion system are:

i. Compressor

ii. Condenser

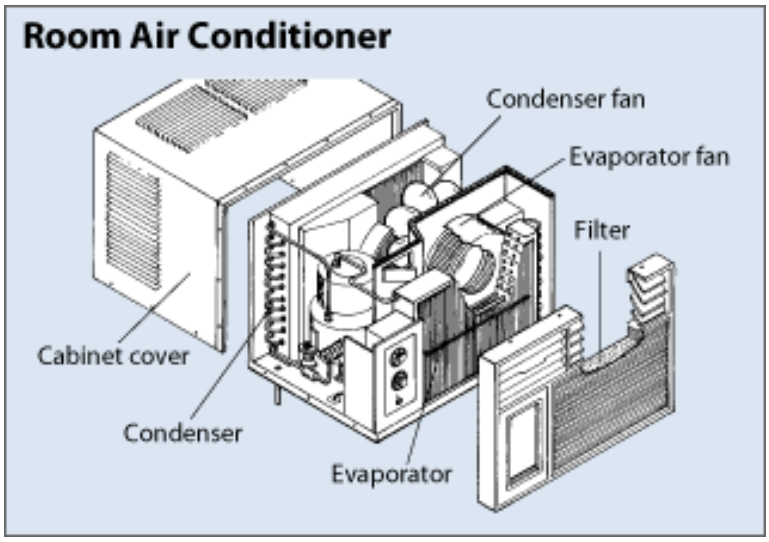
iii. Evaporator (or) Cooling coil with fan

iv. cooling tower (in case of water-cooled condenser)

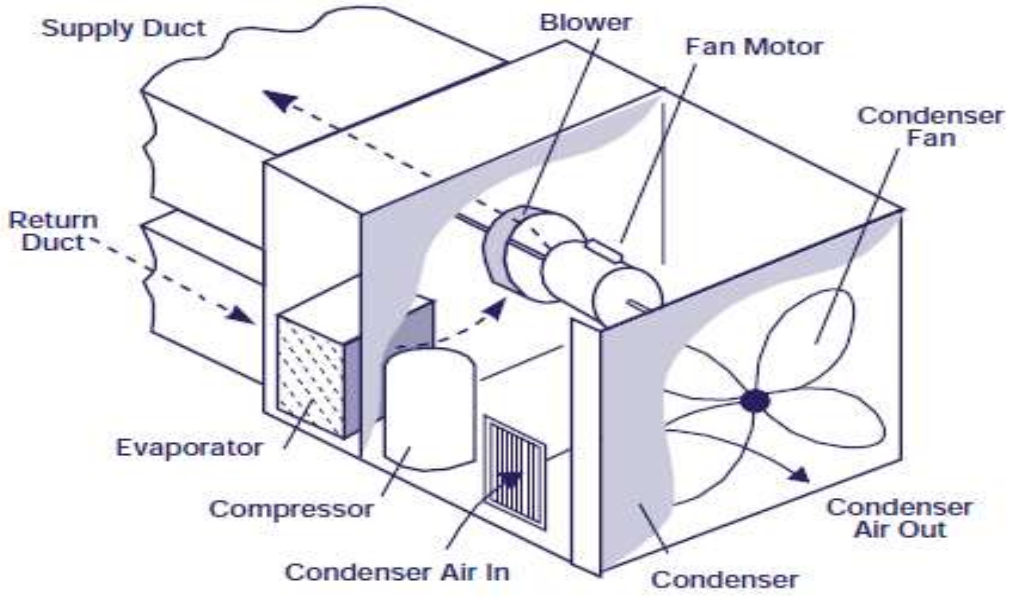
v. condenser water pump set

vi. Air distribution

i. Room air conditioner: There are self-contained air conditioning units, comprising of a compressor, evaporator, fan and air-cooled condenser. This type of plant is used for single rooms having limited occupancy. These units are ideally suited for bed rooms of similar applications.



ii. Packaged units: Packaged air conditioner comprises of a compressor, water cooled condenser, evaporator and fan, all mounted in a sheet metal cabinet. They are ideally suited for residence, shops, banks, offices and some industrial applications.



iii. Central-direct expansion plants: In this system, all the equipment pertaining to air conditioning is installed in a central plant room, and the conditioned air is distributed to the rooms, halls, enclosures by ducts. The system is more useful for factories, hotels, assembly halls, cinema halls and big residential buildings where it is un economical to install separate units for each room.

(b) Chilled Water (Indirect) System: In this system, secondary medium, such as water is used to cool the air. The refrigerant first cools the water and then the water cools the air. The main components of this system are the same as direct expansion system but a chiller is the additional item. Following is the list of the components of the system.

i. compressor

ii. condenser (mostly water-cooled)

iii. chiller

iv. Air handling unit with chilled water coil and/or fan coil unit or chilled water air washers.

v. cooling tower

vi. chilled water and condenser water pump sets.

vii. Air distribution ducting and grills.

Selection of Air Conditioning System:

The selection of correct air conditioning system for a particular building depends upon the following factors:

i. Capital cost

ii. Running and operating cost

iii. Space for the locating of the equipment.

iv. Type of application whether comfort application or industrial application.

Lighting

It is only recently that day lighting has come to be regarded as a functional requirement. Good lighting is necessary to do any work in comfort. A

building with bad lighting is a inefficient through it may look attractive superficially. Thus it is necessary to take necessary precautions while designing the building so as to provide good lighting.

Aims of good lighting:

Good lighting is necessary for all buildings and has three primary aims

The first aim is to promote work and other activities carried out with in the buildings.

The second aim is to promote the safety of the people using the building.

The third aim is to create a pleasing environment conductive to interest of the occupants and a sense of their well-being.

Units of light:

Lumen (Im): SI units of luminous flux: The luminous flux emitted with in unit solid angle by a point source having a uniform intensity of one candela.

Units of illumination: (Lux)

Lux: This is defined as one lumen per square meter

Recommended values of illumination:

The table given below gives recommended values of illumination these are valied under most of the conditions whether the illumination is day lighting, artificial lighting or combined of the two.

Offices-school and public buildings

Visual task	Illumination-Lux
Assembly and concert	
a) Foyers and auditoria	100 to 150
b) Plat forms	450
c) corridors	70
d) stairs	100
Banks	
a) Counters typing & accounting book areas	300
b) Public areas	150
Cinemas	

a) foyers	150
b) Auditoria	50
c) corridors	70
d) stair	100
Office	
a) entrance hall & reception areas	150
b) conference rooms & executive office	300
c) General office	300
d) Business machine operation	450
e) Drawing office	
i. General	300
ii. Boards & tracing	450
Schools & Colleges	
a) Assembly halls	
i. General	150
ii. When used for examination	300
iii. Platforms	300
b) Class/ Lecture room	
i. Desks	300
ii. Chalk boards	200 to 300
c) Laboratories	300

ENVIRONMENTAL SANITATION

III Year – I Semester

Unit-VI

Occupational Health and Safety

Learning Material

Occupational Hazards:

- An occupational hazard is a hazard experienced in the workplace.
- Occupational hazards can encompass many types of hazards, including chemical hazards, biological hazards (biohazards), psychosocial hazards, and physical hazards.
- In the United States, the National Institute for Occupational Safety and Health (NIOSH) conduct workplace investigations and research addressing workplace health and safety hazards resulting in guidelines.
- The Occupational Safety and Health Administration (OSHA) establishes enforceable standards to prevent workplace injuries and illnesses. In the EU a similar role is taken by EU-OSHA.
- Occupational hazard as a term signifies both long-term and short-term risks associated with the workplace environment.
- Short term risks may include physical injury, while long-term risks may be increased risk of developing cancer or heart disease.

Occupational health:

It refers to the potential risks to health and safety for those who work outside the home.

Hazard:

Something that can cause harm if not controlled.

Occupational diseases:

Diseases directly caused by a persons occupation.

Physical: e.g. heat, noise, radiation

Chemical: e.g. solvents, pesticides, heavy metals, dust

Biological: e.g. tuberculosis, hepatitis B virus, HIV

Ergonomic: e.g. improperly designed tools or work areas, repetitive motions

Psychosocial stressors: e.g. lack of control over work, inadequate personal support

Mechanical: these mainly cause work accidents and injuries rather than occupational diseases.

- Every day in America, 12 people go to work and never come home.
- Every year in America, 3.3 million people will suffer a work place injury from which they may never recover.
- Men are 13 times more likely to die at work than women.

Occupational Hazard:

i. Physical hazard:- *Physical hazard is a sub-type of occupational hazard that involve environmental hazards that causes harm with or without contact.*

This physical hazard include

- ✓ *Noise*
- ✓ *Vibration*
- ✓ *Radiation*
- ✓ *Heat*
- ✓ *Dusts*

Noise, for example, is a significant physical hazard, which can be controlled by:

- installing equipment and systems that have been engineered, designed and built to operate quietly
- enclosing or shielding noisy equipment
- making certain that equipment is in good repair and is properly maintained with all worn or unbalanced parts replaced
- mounting noisy equipment on special mounts to reduce vibration
- installing silencers, mufflers or baffles
- substituting quiet work methods for noisy ones, e.g. welding parts rather than riveting them

- treating floors, ceilings and walls with acoustic material to reduce reflected or reverberant noise
- erecting sound barriers at adjacent workstations around noisy operations to reduce worker exposure to noise generated at adjacent workstations
- increasing the distance between the source and the receiver, e.g. by isolating
- workers in acoustic booths, limiting workers' exposure time to noise and providing hearing protection.

ii. Chemical hazard:- Chemical hazard is a sub type of occupational hazard that involve dangerous chemicals, exposure to chemicals in the workplace can cause acute or long-term detrimental health effects.

The workplace exposure to hazards such as silica dust, welding fumes and vapours exert toxic effects by inhalation (breathing), absorption (through direct contact with the skin) or ingestion (eating or drinking) their causes the heart disease, stroke and high blood pressure.

iii. Biological Hazard:- Those who work outdoors encounter numerous biological hazards, including bites and stings from insects, spiders, snakes and scorpions.

According to NIOSH, outdoor workers at risk for these hazards include farmers, foresters, landscapers, ground-skeepers, gardeners, painter, roofers, pavers, construction workers, laborers, mechanics and any other workers who spen time outside.

iv. Psychological hazard:- This psychological hazard that effect someones social life (or) psychological health. Psychological hazards in the workplace include occupational burnout and occupational stress, which can lead to burnout.

- ✓ Job stress
- ✓ Job organization
- ✓ unsociable hours
- ✓ Frustration
- ✓ Lack of job satisfaction
- ✓ poor human relationship
- ✓ Emotional tensions etc

Interaction between work and health

- The social and economic importance of work receives considerable attention because a primary function of work in any society is to produce and distribute goods and services.
- Far less attention is paid to the importance of work to the individual, yet it is clear from recent research that work plays a crucial and perhaps unparalleled psychological role in the formation of self-esteem and a sense of order.
- Work is a powerful force in shaping a person's sense of identity. It can lend vitality to existence and establishes the cyclical patterns of day, week, month and year. It is believed that work for which there is no economic gain, such as child care, care for the aged and voluntary work, also has its rewards and contributes to personal gratification.

Health hazards:

- When work is associated with health hazards, it may cause occupational disease, be one of the multiple causes of other disease or may aggravate existing ill-health of non-occupational origin.
- In developing countries, where work is becoming increasingly mechanized, a number of work processes have been developed that treat workers as tools in production, putting their health and lives at risk.
- The occupational health lessons learned during the Industrial Revolution should be borne in mind in planning for health in developing countries if such problems are to be avoided.

Occupational hazard in hospitals:

- Occupational health risks for healthcare workers
- Health hazards in health care facilities
- Physical hazards- slips, trips, temperature changes
- Chemical hazards- hazardous drugs, cleaning and sterilizing agents.
- Biological Hazards- Infective diseases blood borne pathogens, needle stick injuries.
- Ergonomic hazards
- Psychosocial hazard- occupational stress, workplace violence

Occupational hazard in Food service industry

Occupational safety and health (OSH) is increasingly recognized by government and international organizations as an important part of public health.

- Burns- There are many hot things that can cause burns, including fryers, stoves, ovens, and boiling water.
- Cuts and punctures- Because food establishments have knives, and glass dishes, it is not surprising that sometimes employees get cut.
- Strains and other muscle injuries- Workers often have to reach across large tables to clear them or grab items off of high shelves. These movements can cause strains. Food service workers also have to carry heavy items, like large tray, which can strain muscles.
- Tripping- You may have noticed that many food establishments have large rugs. If a corner of a rug is not perfectly flat, it can cause someone to trip.
- Eye problems- Obviously, getting something in your eye runs the risk of damage. In food establishments, there are many eye hazards, such as grease, and even cleaning products.

Preventive measures:

- Wearing protective clothing (boots, gloves, spectacles, masks, aprons).
- Covering skin lesions with water proof dressings.
- Preventing access to or giving adequate warnings about water bodies known or suspected to be contaminated (pools, ponds, rivers).
- Washing or showering after exposure to urine splashes or contaminated soil or water.
- Washing and cleaning wounds.
- Consuming clean drinking water.

WELL Building Standard:

Performance Verification entails a site visit during which a WELL Assessor performs or oversees tests and inspections to verify that all applicable requirements of WELL features have been met.

Scheduling Performance Verification

- For a project seeking to achieve WELL Certification, certain conditions must be met before the project can schedule Performance Verification. These vary based on the project type. For projects utilizing WELL pilot standards, there may be additional criteria as outlined in the introduction to the pilot standard.
- All documents for which the project team is responsible must be submitted, reviewed and approved in WELL Online through the Documentation Review process.
- At least one month must pass since the space's certificate of occupancy was issued.
- A minimum of 50% of expected occupancy must be achieved in the project.

On-Site Measurements and Inspections:

Performance Verification is performed or overseen by the WELL Assessor. Depending on the building size, this may require the WELL Assessor (and testing organization, if applicable) to be at the site for multiple days in order to fully validate the project's design documentation via inspections and spot-checks, and to complete all on-site performance tests to confirm adherence to WELL requirements.

Due to the nature of performance testing, there are variables outside of the control of GBCI or IWBI that could impact the Performance Verification timeline. Performance Verification involves analysis performed by various third-party laboratories for radon, formaldehyde, VOCs, and up to 32 different water contaminants. In some cases, the results analysis may take additional time. Additionally, if the results from the laboratory are outside of the accepted

accuracy or tolerance range outlined in the Performance Verification Guidebook, or if laboratory samples are damaged during shipping, additional testing may be required and could increase the certification

1. Air quality (e.g., organic and inorganic gases, and particulates)
2. Water quality (e.g., dissolved chemicals and suspended solids)
3. Light attributes (e.g., color quality, intensity and spectral power distribution)
4. Thermal considerations (e.g., ambient and radiant temperature, air speed and humidity)
5. Acoustic elements (e.g., decibel levels and reverberation)

Any WELL feature and its parts are subject to verification on-site by the WELL Assessor during Performance Verification, including those accounted for by documentation. This means that the WELL Assessor will perform spot-checks and confirm on-site that certain features reflected in the submitted documents are in fact satisfied

AWARD & CONTINUED ENGAGEMENT

Certification Award

- Projects that have satisfied the requirements of WELL and have accepted the WELL report will receive a WELL award package from IWBI.
- The WELL building award package will contain the official award letter, the WELL Certification plaque and other relevant documents and signage. IWBI will also provide sample materials to assist the project in its promotion of successful WELL Certification.
- The WELL Certified plaque or other signage will indicate the level of certification and the year certified, and may only be displayed at the site of the WELL Certified project. For additional details, please view the IWBI Trademark Policy and Branding Guidelines.

Continued Engagement

- In order to maintain status as a WELL Certified project prior to recertification, there are specific ongoing requirements.
- Certain features may require projects to provide ongoing records of the following:
- A. Results of post-occupancy surveys
- B. Proof of maintenance (e.g., logs of cleaning schedules and filter replacement)
- C. Ongoing environmental parameter measurements (e.g., air and water quality)
- To remain in good standing, projects must submit the documents within 15 months of certification and then every 12 months thereafter. Failure to provide these documents within this time frame may result in an

additional fee assessed at recertification. If the ongoing records are not submitted at all by recertification, then in addition to the fee, the project will be ineligible to pursue these features for the following certification period. For details on what is required in these documents, please refer to the relevant features in the WELL Building Standard or WELL Community Standard timeline. Any additional testing is done to ensure the accuracy of the results and for the benefit of the project team.

- During performance verification, an individual with authorized access to all areas of the building must be present so that performance tests and inspections may be conducted in any area, including mechanical and tenant spaces, grounds and the roof. Testing and measurement during Performance Verification will be completed according to sampling protocols set by IWBI based on the size and project type of the project, and some collected samples will be sent to a third-party laboratory for analysis.

OH&S Management System elements:

As discussed earlier, BS OHSAS 18001 is aligned with ISO 14001, which is based upon the 'Plan, Do, Check, Act' structure pioneered by the American quality expert W. Edwards Deming in the 1950's. This simple but effective structure is still used today to ensure that the hazards and risks associated with organizations activities, products and services are systematically identified and assessed, controlled, monitored and continuously improved.