Program : **B.Tech**

Subject Name: **Waste disposal & Management**

Subject Code: **CE-8004**

Semester: **8th**

Unit: -2

Waste Water and Its Management: Waste Water And Its Management: Characteristics and analysis of waste water, recycles of decomposition, physical, chemical & biological parameters. Unit operations for waste water treatment, preliminary treatment.

Wastewater:

Wastewater is any water that requires cleaning after it is used. This includes water that has been used for laundry, bathing, dish washing, toilets, garbage disposals, and industrial purposes. Wastewater also includes rainwater that has accumulated pollutants as it runs into oceans, lakes, and rivers. Pollutants are unwanted chemicals or materials that contaminate air, soil, and water.

The goal of wastewater management is to clean and protect water. This means that water must be clean enough so that it can be used by people for drinking and washing, and by industry for commercial purposes. It also must be clean enough to release into oceans, lakes, and rivers after it has been used.

Wastewater is usually divided into two major groups:

- point source wastewater
- non-point source wastewater

Point source wastewater includes waste waters that enter natural waters (such as lakes, rivers, and oceans) from defined locations. The most common point sources are sanitary sewers and storm drains. Non-point source wastewater is wastewater that is not connected to a specific source. This includes runoff (water that drains away) from agriculture and urban (city) areas, and acidic waters from mines. In many ways, point source wastewater is much easier to manage because its source and the pollutants it contains are known.

Non-point source wastewater, on the other hand, is both hard to identify and treat.

Basic Characteristics Of Wastewater:

Introduction

Wastewater is defined as any water that has been negatively affected in quality by humans. Wastewater is comprised of liquid and solid waste that is discharged from domestic residences, commercial properties, industrial plants, and agriculture facilities or land. Wastewater contains a wide range of contaminants at various concentrations.

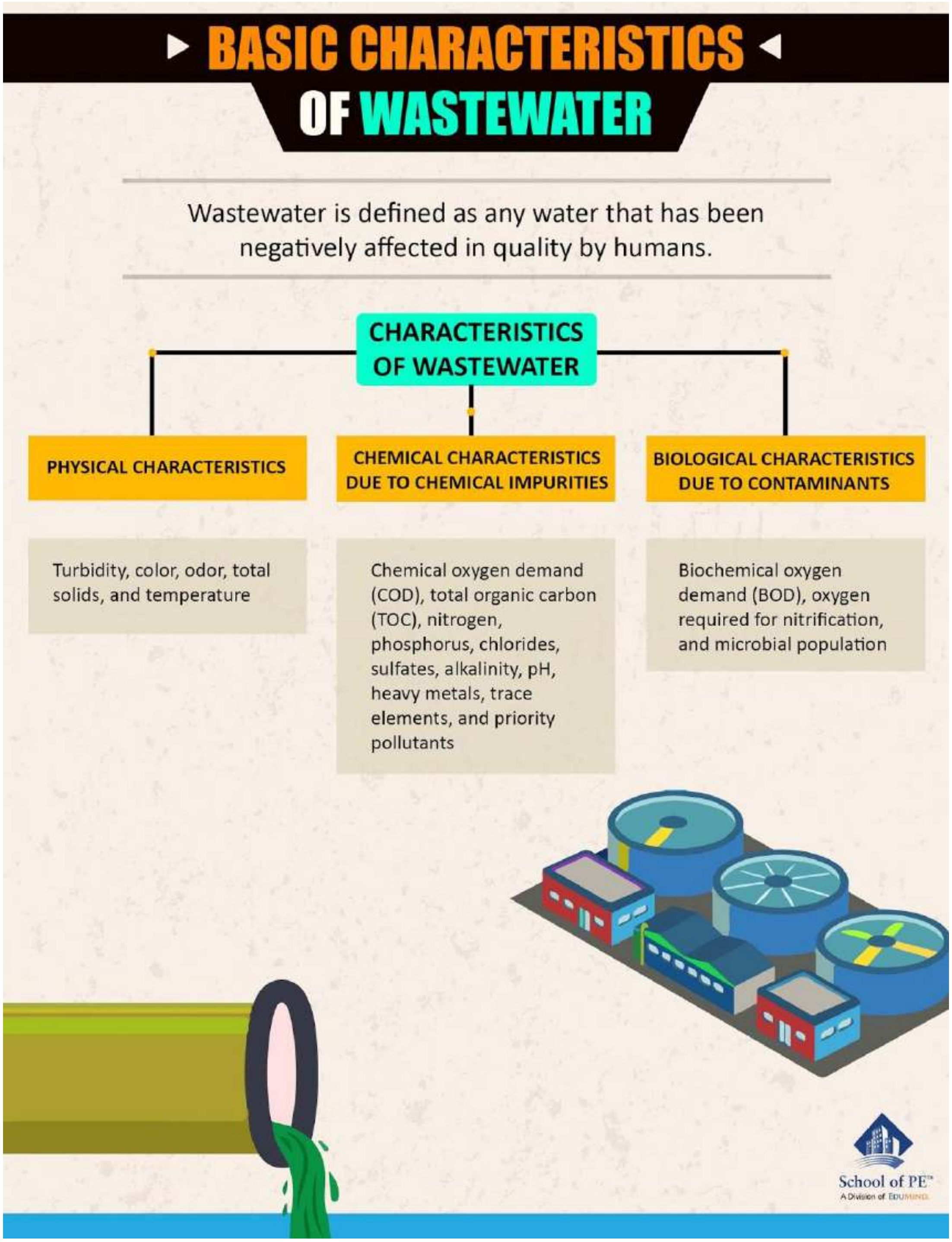


Figure: Characteristics of Wastewater

The three main characteristics of wastewater are classified below.

1. Physical Characteristics

- Turbidity
- Color
- Odor
- Total solids
- Temperature

2. Chemical Characteristics due to Chemical Impurities

- Chemical Oxygen Demand (COD)
- Total Organic Carbon (TOC)
- Nitrogen
- Phosphorus
- Chlorides
- Sulfates
- Alkalinity
- pH
- Heavy Metals
- Trace Elements
- Priority Pollutants

3. Biological Characteristics due to Contaminants

- Biochemical Oxygen Demand (BOD)
- Oxygen required for nitrification
- Microbial population

Wastewater characteristics, as well as water treatment processes, are important for environmental engineers to understand. Our FE Environmental exam review course thoroughly reviews the characteristics of wastewater.

1. Physical Characteristics of Wastewater:

- Color - Fresh sewage is normally brown and yellowish in color but over time becomes black in color.
- Odor – Wastewater that includes sewage typically develops a strong odor.
- Temperature - Due to more biological activity, wastewater will have a higher temperature.
- Turbidity - Due to suspended solids in wastewater, wastewater will have a higher turbidity, or cloudiness.

2. Chemical Characteristics of Wastewater:

Wastewater contains different chemicals in various forms as mentioned below.

- Chemical Oxygen Demand (COD) - COD is a measure of organic materials in wastewater in terms of the oxygen required to oxidize the organic materials.

- **Total Organic Carbon (TOC) - TOC is a measure of carbon within organic materials.**
- **Nitrogen - Organic nitrogen is the amount of nitrogen present in organic compounds.**
- **Phosphorous - Organic phosphorous (in protein) and inorganic phosphorous (phosphates, PO4-)**
- **Chlorides (Cl-)**
- **Sulfates (SO4-2)**
- **Heavy metals**
  1. **Mercury (Hg)**
  2. **Arsenic (As)**
  3. **Lead (Pb)**
  4. **Zinc (Zn)**
  5. **Cadmium (Cd)**
  6. **Copper (Cu)**
  7. **Nickel (Ni)**
  8. **Chromium (Cr)**
  9. **Silver (Ag)**

Analyzing the physical and chemical characteristics of wastewater plays a critical role in the wastewater treatment process. Our FE Environmental review course greatly emphasizes wastewater treatment methods based on the physical and chemical characteristics of the water.

3. Biological Characteristics of Wastewater:

- **Biochemical Oxygen Demand (BOD) - BOD is the amount of oxygen needed to stabilize organic matter using microorganisms.**
- **Nitrogenous Oxygen Demand (NOD) - NOD is the amount of oxygen needed to convert organic and ammonia nitrogen into nitrates by nitrifying bacteria.**
- **Microbial life in wastewater - Wastewater contains the following microbes:**
  1. **Bacteria**
  2. **Protozoa**
  3. **Fungi**
  4. **Viruses**
  5. **Algae**
  6. **Rotifers**
  7. **Nematodes**
- **Oil and Grease - Oil and grease originate from food waste and petroleum products. The amount of oil and grease in raw wastewater varies from 10 to 109 mg/L.**

It is important that those who are striving to obtain their FE certification fully understand how to regulate the biological characteristics of wastewater through appropriate treatment methods.

Wastewater Recycling

Wastewater recycling helps customers optimize water costs and minimize their environmental footprint. With leading technologies and proven expertise across some of Africa's most important wastewater recycling plants, Eolian treats even the dirtiest of wastewater and industrial effluent to potable and ultrapure standards with customize wastewater recycling solutions.

WASTEWATER RECYCLING FOR MUNICIPALITIES:

- Reduces reliance on stressed fresh water sources
- Frees up bulk water, which can soften the need to invest in new potable plants builds
- Protect sensitive ecosystems and reclaim natural aquifer.

WASTEWATER RECYCLING FOR INDUSTRY:

- Reduce bulk water consumption = lower per-litre cost of water
- Improve compliance with environmental regulations
- Harvest valuable minerals from wastewater for secondary revenue streams
- Work towards Zero Liquid Discharge!

RECYCLE WASTEWATER TO ANY STANDARD

The far lower per-unit cost of recycled wastewater over municipal bulk water supply is a significant financial opportunity for big water users to greatly reduce their water CAPEX. Especially for process water, where potable water is not needed and presents unnecessary treatment costs that are borne by the end user, wastewater recycling is an investment for any consumer.

No matter your application, Eolian will help you achieve your treatment requirements with unmatched technological know-how and application skill. From acid mine drainage through to sewage treatment, we cover the complete recycling spectrum with over 350 proprietary technologies

Physical, chemical & biological parameters

Water has three characteristics, i.e. physical, chemical and biological characteristics. The raw treated water can be checked and analyzed by studying and testing these characteristics as explained below:

Wastewater reuse:

Wastewater can be a valuable resource in cities or towns where population is growing and water supplies are limited. In addition to easing the strain on limited freshwater supplies, the reuse of wastewater can improve the quality of streams and lakes by reducing the effluent discharges that they receive. Wastewater may be reclaimed and reused for crop and landscape irrigation, groundwater recharge, or recreational purposes. Reclamation for drinking is technically possible, but this reuse faces significant public resistance.

There are two types of wastewater reuse: direct and indirect. In direct reuse, treated wastewater is piped into some type of water system without first being diluted in a natural stream or lake or in groundwater. One example is the irrigation of a golf course with effluent from a municipal wastewater treatment plant. Indirect reuse involves the mixing of reclaimed wastewater with another body of water before reuse. In effect, any community that uses a surface water supply downstream from the treatment plant discharge pipe of another community is indirectly reusing wastewater. Indirect reuse is also accomplished by discharging reclaimed wastewater into a groundwater aquifer and later withdrawing the water for use. Discharge into an aquifer (called artificial recharge) is done by either deep-well injection or shallow surface spreading.

Quality and treatment requirements for reclaimed wastewater become more stringent as the chances for direct human contact and ingestion increase. The impurities that must be removed depend on the intended use of the water. For example, removal of phosphates or nitrates is not necessary if the intended use is landscape irrigation. If direct reuse as a potable supply is intended, tertiary treatment with multiple barriers against contaminants is required. This may include secondary treatment followed by granular media filtration, ultraviolet radiation, granular activated carbon adsorption, reverse osmosis, air stripping, coronation, and chlorination.

The use of gray-water recycling systems in new commercial buildings offers a method of saving water and reducing total sewage volumes. These systems filter and chlorinate drainage from tubs and sinks and reuse the water for no potable purposes (e.g., flushing toilets and urinals). Recycled water can be marked with a blue dye to ensure that it is not used for potable purposes.

A. Physical Characteristics of Water:

1. Turbidity of Water:

The turbidity is measured by a turbidity rod or by a turbidity meter with optical observations and is expressed as the amount of suspended matter in mg/l or parts per million (ppm). For water, ppm and mg/l are approximately equal.
The standard unit is that which is produced by one milligram of finely divided silica (fuller's earth) in one liter of distilled water.
Turbidity Rod: The turbidity can be easily measured in the field with the help of a turbidity rod. It consists of an aluminum rod which is graduated as to give turbidity directly in silica units (mg/l).
Turbidimeter: The turbidity can be easily measured in the laboratory with the help of a instruments called turbidity meter. In general, a turbidity meter works on the principle of measuring the interference caused by the water sample to the passage of light rays.

2. Colour

The presence of colour in water is not objectionable from health point of view, but may spoil the colour of the clothes being washed. The standard unit of colour is that which is produced by one milligram of platinum cobalt dissolved in one litre of distilled water.

For public supplies, the colour number on cobalt scale should not exceed 20 and should be preferably less than 10.

Colour determined by an instrument is known as tintometer.

3. Taste and Odour

The extent of taste or odour present in a particular sample of water is measured by a term called odour intensity, which is related with the threshold odour or threshold odour number.

Water to be tested is therefore gradually diluted with odour free water, and the mixture at which the detection of odour by human observation is just lost, is determined. The number of times the sample is diluted represents the threshold odour number.

For public supplies, the water should generally free from odour, i.e. the threshold number should be 1 and should never exceed 3.

4. Temperature of Water

For potable water, temperature of about about 10^o C is desirable. It should not be more than 25^o C.

5. Specific Conductivity

The total amount of dissolved salts present in water can be easily estimated by measuring the specific conductivity of water.

B. Chemical Characteristics of Water:

1. Total Solids and Suspended Solids:

Total solids (suspended solids + dissolved solids) can be obtained by evaporating a sample of water and weighing the dry residue left and weighing the residue left on the filter paper.

The suspended solid can be found by filtering the water sample. Total permissible amount of solids in water is generally limited to 500 ppm.

2. pH value of Water

$$pH = -\log[H^+] = \log\left[\frac{1}{H^+}\right]$$

If H^+ concentration increases, pH decreases and then it will be acidic.

If H^+ concentration decreases, pH increases and then it will be alkaline.

$[H^+][OH^-] = 10^{-14}$

pH + pOH = 14

if the pH of water is more than 7, it will be alkaline and if it is less than 7, it will be acidic.

The alkalinity is caused by the presence of bicarbonate of calcium and magnesium or by the carbonates of hydroxides of sodium, potassium, calcium and magnesium.

Some, but not all of the compounds that cause alkalinity also cause hardness.

pH Measurement:

the pH value of water can be measured quickly and automatically with the help of a

Potentiometer.

The pH can also be measured by indicators as given below:

Indicator	pH range of indicator dye	Original color	Final color produced
Methyl orange	2.8 – 4.4	Red	Yellow
Methyl red	4.4 – 6.2	Red	Yellow
Phenol red	6.8 – 8.4	Yellow	Red
Phenolphthalein	8.6 – 10.3	Yellow	Red

Permissible pH value for public supplies may range between 6.6 to 8.4.

The lower value of pH may cause incrustation, sediment deposits, and difficulty in chlorination.

3. Hardness of Water:

Hard waters are undesirable because they may lead to greater soap consumption, scaling of boilers, causing corrosion and incrustation of pipes, making food tasteless etc.

Temporary Hardness: If bicarbonates and carbonates of calcium and magnesium are present in water, the water is render hard temporarily as this hardness can be removed to some extent by simple boiling or to full extent by adding lime to water. Such hardness is known as temporary hardness or carbonate hardness.

Permanent Hardness: If sulphates, chlorides and nitrates of calcium or magnesium are present in water, they cannot be removed at al by simple boiling and therefore, such water require special treatment for softening. Such hardness is known as permanent hardness or non-carbonate hardness.

It is caused by sulphates, chlorides, nitrates of Ca and Mg.

Carbonate hardness = Total hardness or Alkalinity (which ever is less).

Non-carbonate hardness = Total hardness – Alkalinity

- Carbonate hardness is equal to the total hardness or alkalinity which ever is less
- Non-carbonate hardness is the total hardness in excess of the alkalinity. If the alkalinity is equal to or greater than the total hardness, there is no non-carbonate hardness.
- One French degree of hardness is equal to 10mg/l of $CaCO_3$.
- One British degree of hardness is equal to a hardness of 14.25mg/l.
- Water with hardness upto 75 ppm are considered soft and above 200 ppm are considered hard and in between is considered as moderately hard.
- Underground waters are generally harder than surface waters.
- The prescribed hardness limit for public supplies range between 75 to 115 ppm.

4. Chloride Content:

The chloride content of treated water to be supplied to the public should not exceed a value of about 250 ppm.

The chloride content of water can be measured by titrating the water with standard silver nitrate solution using potassium chromate as indicator.

5. Nitrogen Content:

The presence of nitrogen in water may occur in one or more of the following reasons:

1. Free ammonia: It indicates very first stage of decomposition of organic matter. It should not exceed 0.15mg/l
2. Aluminous or Organic Matter: It indicates the quantity of nitrogen present in water before the decomposition of organic molten has started. It should not exceed 0.3mg/l
3. Nitrites: Not fully oxidized organic matter in water.
4. Nitrates: It indicates fully oxidized organic matter in water (representing old pollution).

- Nitrites are highly dangerous and therefore the permissible amount of nitrites in water should be nil.
- Ammonia nitrogen + organic nitrogen = kjeldahl nitrogen
- Nitrates in water are not harmful. However the presence of too much of nitrates in water may adversely affect the health of infants causing a disease called methemoglobinemia commonly called blue baby disease.
- The nitrate concentration in domestic water supplies is limited to 45 mg/l.

6. Metal and other chemical substances in water:

Iron – 0.3ppm, excess of these cause discoloration of clothes.

Manganese – 0.05ppm

Copper – 1.3ppm

Sulphate – 250 ppm

Fluoride – 1.5 ppm, excess of this effects human lungs and other respiratory organs.

Fluoride concentration of less than 0.8 – 1.0 ppm cause dental cavity (tooth decay). If fluoride concentration is greater than 1.5ppm, causing spotting and discoloration of teeth (a disease called fluorosis).

7. Dissolved gases:

Oxygen gas is generally absorbed by water from the atmosphere but it being consumed by unstable organic matter for their oxidation. Hence, if the oxygen present in water is found o be less than its saturation level, it indicates presence of organic matter and consequently making the waters suspicious.

Biological Oxygen Demand (BOD):

The extent of organic matter present in water sample can be estimated by supplying oxygen to this sample and finding the oxygen consumed by the organic matter present in water. This oxygen demand is known as Biological oxygen demand (BOD).

It is not practically possible to determine ultimate oxygen demand. Hence, BOD of water during the first five days at 20^o C is generally taken as the standard demand.

$BOD_5 = BOD \text{ of } 5 \text{ days}$ = Loss of oxygen in mg/l x dilution factor.

The BOD of safe drinking water must be nil.

Bacterial and Microscopic Characteristics of Water.

Five types of parasitic organisms (i.e. bacteria, protozoa, viruses, worms and fungi) are generally known to be infective to main and are found in water.

1. Bacteria

These are the minute single cell organisms possessing no defined nucleus and having no green material to help them manufacture their own food. They are reproduced by binary fusion and may of various shapes and sizes are 1 to 4 microns, examined by microscope.

a) Non-disease causing bacteria – Non pathogenic bacteria.

b) Disease causing bacteria – Pathogenic bacteria.

2. Protozoa

These are single cell animals and are the lowest and the simplest form of animal life. They are bacteria eaters and thus destroy Pathogens. They are counted by microscope.

3. Viruses

4. Worms

These are the larva of flies.

5. Fungi

These are those plants which grow without sunlight and live on other plants or animals, dead or alive.

Classification of bacteria based on oxygen requirement:

1. Aerobic bacteria: Those which require oxygen for their survival.
2. Anaerobic bacteria: Those which flourish in the absence of free oxygen.
3. Facultative bacteria: Those which can survive with or without free oxygen.

Pathogenic bacteria:

These can be tested and counted in the laboratories but with great difficulty. These tests are therefore, generally not performed in routine to check up of the water quality. The usual routine tests are generally conducted to detect and count the presence of coliforms which in themselves harmless organisms, but their presence or absence indicates the presence or absence of pathogenic bacteria.

Methods to measure the presence of coli form bacteria:

1. Membrane filter technique (modern technique)

2. Mixing different dilution of a sample of water with lactose froth and incubating them in test-tubes for 48 hours at 37^{o} C. the presence of acid or carbon dioxide gas in tubes will indicate the presence of coliform bacteria.

Most probable number (MPN) represents the bacterial density.

Coliform index:

It may be defined as the reciprocal of the smallest quantity of a sample which would give a positive portion. Coliform sometimes called bacteria coli (B-coli) or Escherichia (E-coli) are harmless aerobic micro-organisms.

If not more than 1 coliform is present per 100ml of water, then water is said to be safe for drinking.

$$\mathrm{MPN/100ml} = \frac{100\times \text{ Number of positive portion}}{\sqrt{(\text{ml. in all positive porion})\ x\ (\text{ml. in all negative portion})}}$$

Principles of Unit operations and processes in water and wastewater treatment and disposal :

Water and waste water differ only in the way that solids concentration will be more in waste water and which will be there in water too if the same is taken from the river water which makes the treatment process to both the same except that filtration is on straining the finer particles in water treatment and is towards biological action of bacteria on the trickling filter to remove organic solids. Unit operations are the physical operations to remove the impurities present in the water and waste water where as the unit processes are the chemical and biological conversion on the status of the impurities that they will be converted to a form that can be easily separated. Both are applied especially to make the fine colloidal particles to coalesce and grow in size to be removed from the water or waste water.

There is no impurity that can be categorized as inorganic, it is named so for it takes time to disintegrate and had been to this hard form, free from decomposable matter with the ecological factors. We can find metal eating bacteria these days that makes the accelerated form to human use get decelerated to favor nature accommodate effectively as indigenous. Screens are in use from the intake structure where they prevent the floating matter to enter into the pumping units, and fine and coarse screens are in use to treat waste water to prevent the entry of floating wastes and coarse solids into the treatment.

Sedimentation is simply detaining water for a sufficient time mostly in stagnant or relatively stagnant position to make the flow velocity of water less than the settling velocity of the solid particles that they without being driven by horizontal force settles down by gravity. The efficiency of the process depends on the detention time, how long the waste water remains within the sedimentation tank. When applied to individual units we need not reduce the flow velocity but make it stagnant as fill and draw type that the efficiency will be more. In the continuous flow type the flow velocity is reduced to the level of the minimum velocity which will not carry the particles with it according to stokes law that the vertical velocity, which is the settling velocity of the particle will be more than the.

Horizontal drag velocity and the particle settle down. Mostly the tanks will be rectangular and we also have circular tanks where the flow will be from centre to periphery. Whatever may be the shape of the tank, it is the surface area which makes the travel of particles independent of others which makes the settling efficient that the depth has to be considered taking into effect the sludge accumulation and to prevent the reentry of particles back to flow. Coagulants are added to the water that the flocculent particles grow bigger in size which is by chemical reaction by rapid mixing and slow mixing and the coalescent particles which grew in size gets removed by settling. The coagulant we add changes the quality of water and the sludge volume too, and some of the coagulants add to bulking of sludge where the removal of moisture is difficult. Lime water instead of lime reduces the volume of sludge which is to all the solid coagulants. Liquid coagulants have more influence readily on coagulant particles than the solid coagulants which itself will take time to dissolve and react with the particles.

Filtration is to the removal of fine particle sand dissolved solids where the fine sand layer and coarse sand layer below serves as the media to remove colloidal solids and the water remains completely free of solids. In trickling filters the waste water that trickles down gets oxidized that the organic matter grows in size and retained over the sand medium and bacteria assimilate on the organic matter to form layer on the surface which grows thicker and thicker to give more bacterial mass to act upon the organic solids. The bottom most layer becomes deprived of oxygen in due course of time that it sloughs and the same reaches the secondary settling tank where the same gets settled for its increased density. The activated sludge process is by induced aeration where the reactor is completely mixed with sludge and air, that there will be complete oxidation after which the waste water enters the secondary settling tank. When all solids are removed the minerals present in the water and waste water is removed by reverse osmosis, demineralization process which is basically ion exchange process.

Odour and colour present in water and waste water are removed by aeration and adsorption process. The odour and colour causing elements are adsorbed and aerated that the water is free from impurities for use and waste.

water for reuse and recycling. Toxic chemicals and metals too get adsorbed with suitable media for adsorption. The waste water if not intended for recycling or reuse, they can be altered with low cost biological treatment as septic tank, chess pools, oxidation ponds and ditches which are long time process and adds nutrient value to the soil and can be used for agriculture and this leads to lot of troubles as soil sickness, fly nuisance and skin diseases when the sewage directly comes into contact with the plants. The unit operations and processes can be applied in individual units of houses, colonies and industries that it gives fewer problems to the environment and handled with more efficiency.

Types of Wastewater Treatment Process:

- ETP
- STP

- **CETP**

Some of the major important types of wastewater treatment process are as follows:

1. Effluent Treatment Plants (ETP)

2. Sewage Treatment Plants (STP)

3. Common and Combined Effluent Treatment Plants (CETP).

It is estimated that every year 1.8 million people die due to suffering from waterborne diseases. A large part of these deaths can be indirectly attributed to improper sanitation.

Wastewater treatment is an important initiative which has to be taken more seriously for the betterment of the society and our future. Wastewater treatment is a process, wherein the contaminants are removed from wastewater as well as household sewage, to produce waste stream or solid waste suitable for discharge or reuse. Wastewater treatment methods are categorized into three sub-divisions, physical, chemical and biological.

1. Effluent Treatment Plants (ETP):

Effluent Treatment Plants or (ETPs) are used by leading companies in the pharmaceutical and chemical industry to purify water and remove any toxic and non toxic materials or chemicals from it. These plants are used by all companies for environment protection.

An ETP is a plant where the treatment of industrial effluents and waste waters is done. The ETP plants are used widely in industrial sector, for example, pharmaceutical industry, to remove the effluents from the bulk drugs.

During the manufacturing process of drugs, varied effluents and contaminants are produced. The effluent treatment plants are used in the removal of high amount of organics, debris, dirt, grit, pollution, toxic, non toxic materials, polymers etc. from drugs and other medicated stuff. The ETP plants use evaporation and drying methods, and other auxiliary techniques such as centrifuging, filtration, incineration for chemical processing and effluent treatment.

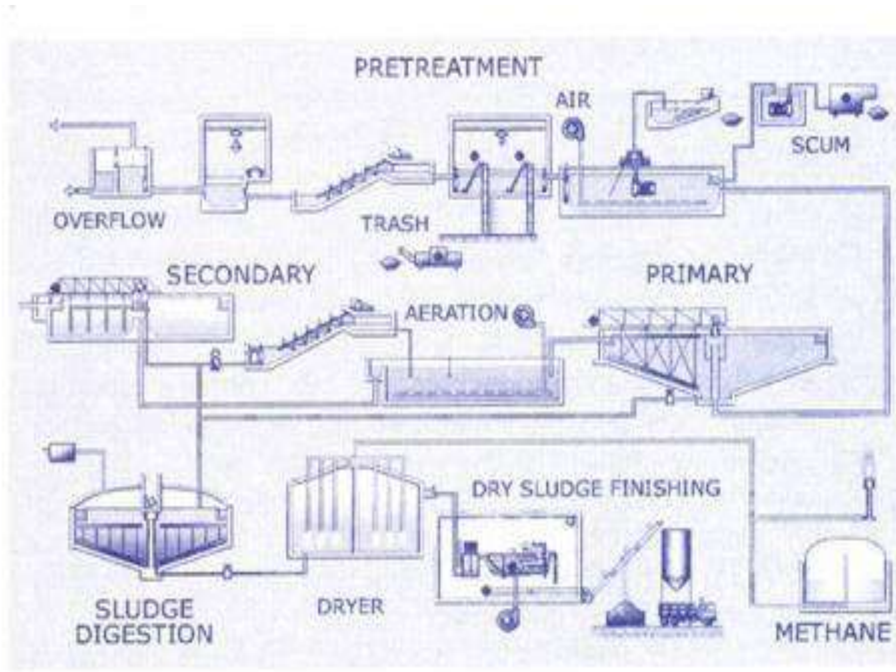
Figure: Effluent Treatment Plants

The treatment of effluents is essential to prevent pollution of the receiving water. The effluent water treatment plants are installed to reduce the possibility of pollution; biodegradable organics if left unsolved, the levels of contamination in the process of purification could damage bacterial treatment beds and lead to pollution of controlled waters. The ETPs can be established in the industrial sectors like Pharmaceuticals, Chemicals and Leather industry and tanneries.

2. Sewage Treatment Plants (STP):

Sewage treatment, or domestic wastewater treatment, is the process of removing contaminants from wastewater and household sewage, both runoff (effluents) and domestic. It includes physical, chemical, and biological processes to remove physical, chemical and biological contaminants.

Its objective is to produce a waste stream (or treated effluent) and a solid waste or sludge suitable for discharge or reuse back into the environment. This material is often inadvertently contaminated with many toxic organic and inorganic compounds.



Process Flow Diagram for a typical large-scale treatment plant.

Figure: Sewage Treatment Plants

Pre-treatment removes materials that can be easily collected from the raw wastewater before they damage or clog the pumps and skimmers of primary treatment clarifiers, for example, trash, tree limbs, leaves, etc., The influent sewage water is strained to remove all large objects carried in the sewage stream. This is most commonly done with an automated mechanically raked bar screen in modern plants serving large populations, whilst in smaller or less modern plants a manually cleaned screen may be used this is called as screening.

The raking action of a mechanical bar screen is typically paced according to the accumulation on the bar screens and/or flow rate. The solids are collected and later disposed in a landfill or incinerated. Pre-treatment may include Grit removal in which, a sand or grit channel or chamber where the velocity of the incoming wastewater is carefully controlled to allow sand, grit and stones to settle.

Primary Treatment:

In the primary sedimentation stage, sewage flows through large tanks, commonly called "primary clarifiers" or "primary sedimentation tanks". The tanks are large enough that sludge can settle and floating material such as grease and oils can rise to the surface and be skimmed off. The main purpose of the primary sedimentation stage is to produce both a generally homogeneous liquid capable of being treated biologically and a sludge that can be separately treated or processed.

Primary settling tanks are usually equipped with mechanically driven scrapers that continually drive the collected sludge towards a hopper in the base of the tank from where it can be pumped to further sludge treatment stages. Grease and oil from the floating material can sometimes be recovered for specifications.

Secondary Treatment:

Secondary treatment is designed to substantially degrade the biological content of the sewage which is derived from human waste, food waste, soaps and detergent. The majority of municipal plants treat the settled sewage liquor using aerobic biological processes. For this to be effective, the biota requires both oxygen and a substrate on which to live.

There are a number of ways in which this is done. In all these methods, the bacteria and protozoa consume biodegradable soluble organic contaminants (e.g. sugars, fats, organic short-chain carbon m molecules, etc.) and bind much of the less soluble fractions into floe. Secondary treatment systems are classified as fixed-film or Suspended- growth.

Characteristics include typically tall, circular filters filled with open synthetic filter media to which wastewater is applied at a relatively high rate. They are designed to allow high hydraulic loading and a high flow-through of air. On larger installations, air is forced through the media using blowers. The resultant wastewater is usually within the normal range for conventional treatment processes.

Activated Sludge:

In general, activated sludge plants encompass a variety of mechanisms and processes that use dissolved oxygen to promote the growth of biological floe that substantially removes organic material. The process traps particulate material and can, under ideal conditions, convert ammonia to nitrite and nitrate and ultimately to nitrogen gas.

3. Common and Combined Effluent Treatment Plants (CETP):

Many of the Small Scale Industries (SSI) are unable to put up the treatment systems individually, the concept of CETP's (Common Effluent Treatment Plants) is envisaged to benefit such industries in treating its effluent before disposal whether it is in stream, land, sewerage system or in rivers and seas. CETP's are set up in the industrial estates where there are clusters of small scale industrial units and where many polluting industries are located.

The Ministry of Environment & Forest, Govt. of India has launched the centrally sponsored scheme, namely, Common Effluent Treatment Plant (CETP) in order to make a cooperative movement of pollution control especially to treat the effluent, emanating from the clusters of compatible Small-Scale Industries. The major objective of the CETP is therefore, to reduce the treatment cost to be borne by an individual member unit to a maximum while protecting the water environment to a maximum.

Figure: Common and Combined Effluent Treatment Plants.

Small-scale industries might not have sufficient energy, space, or funds to set up treatment frameworks of their own, so they depend on a consolidated networking system arrangement of plants to help wipe out wastewater. In industrial centers that make a pocket of contamination, Combined effluent treatment plants are frequently introduced, in order to battle the reach of these organization's belongings.

Your septic tank isn't only a basic tool for keeping your home clean, it is additionally imperative in ecological assurance. A consistent cleaning out of your channels and depletes is one approach to keep squander from clogging up your septic tank.

Primary treatment:

Primary treatment removes material that will either float or readily settle out by gravity. It includes the physical processes of screening, comminution, grit removal, and sedimentation. Screens are made of long, closely spaced, narrow metal bars. They block floating debris such as wood, rags, and other bulky objects that could clog pipes or pumps. In modern plants the screens are cleaned mechanically, and the material is promptly disposed of by burial on the plant grounds. A comminutor may be used to grind and shred debris that passes through the screens. The shredded material is removed later by sedimentation or flotation processes.

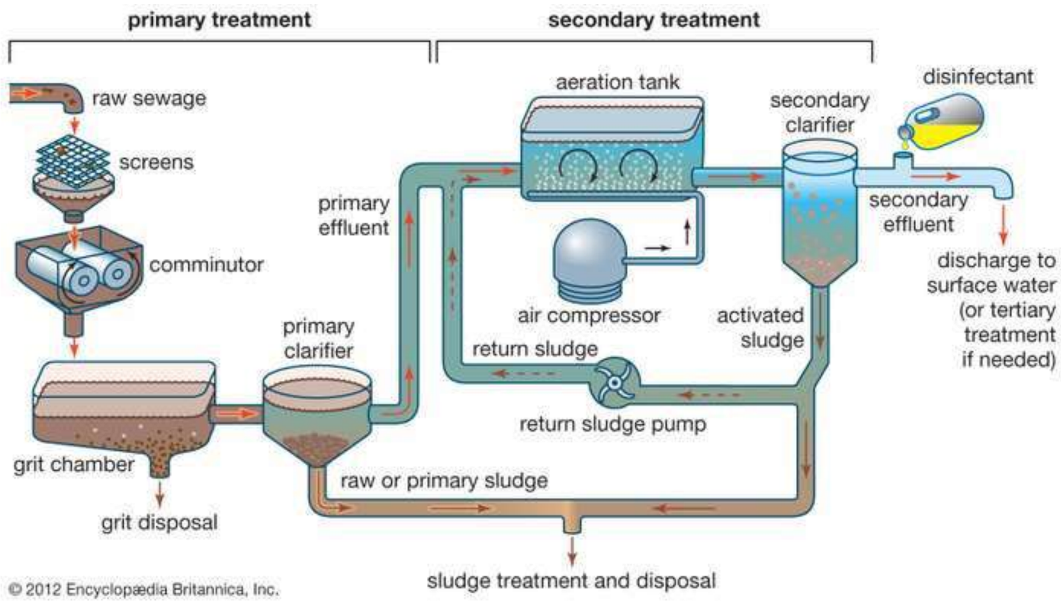


Figure: Primary and secondary treatment of sewage, using the activated sludge process.

Grit chambers are long narrow tanks that are designed to slow down the flow so that solids such as sand, coffee grounds, and eggshells will settle out of the water. Grit causes excessive wear and tear on pumps and other plant equipment. Its removal is particularly important in cities with combined sewer systems, which carry a good deal of silt, sand, and gravel that wash off streets or land during a storm.

Suspended solids that pass through screens and grit chambers are removed from the sewage in sedimentation tanks. These tanks, also called primary clarifiers, provide about two hours of detention time for gravity settling to take place. As the sewage flows through them slowly, the solids gradually sink to the bottom. The settled solids—known as raw or primary sludge—are moved along the tank bottom by mechanical scrapers. Sludge is collected in a hopper, where it is pumped out for removal. Mechanical surface-skimming devices remove grease and other floating materials.

Secondary treatment:

Secondary treatment removes the soluble organic matter that escapes primary treatment. It also removes more of the suspended solids. Removal is usually accomplished by biological processes in which microbes consume the organic impurities as food, converting them into carbon dioxide, water, and energy for their own growth and reproduction. The sewage treatment plant provides a suitable environment, albeit of steel and concrete, for this natural biological process. Removal of soluble organic matter at the treatment plant helps to protect the dissolved oxygen balance of a receiving stream, river, or lake.

There are three basic biological treatment methods: the trickling filter, the activated sludge process, and the oxidation pond. A fourth, less common method is the rotating biological contacted.

A. Trickling filter:

A trickling filter is simply a tank filled with a deep bed of stones. Settled sewage is sprayed continuously over the top of the stones and trickles to the bottom, where it is collected for further treatment. As the wastewater trickles down, bacteria gather and multiply on the stones. The steady flow of sewage over these growths allows the microbes to absorb the dissolved organics, thus lowering the biochemical oxygen demand (BOD) of the sewage. Air circulating upward through the spaces among the stones provides sufficient oxygen for the metabolic processes.

Settling tanks, called secondary clarifiers, follow the trickling filters. These clarifiers remove microbes that are washed off the rocks by the flow of wastewater. Two or more trickling filters may be connected in series, and sewage can be recalculated in order to increase treatment efficiencies.

B. Activated sludge:

The activated sludge treatment system consists of an aeration tank followed by a secondary clarifier. Settled sewage, mixed with fresh sludge that is recirculated from the secondary clarifier, is introduced into the aeration tank. Compressed air is then injected into the mixture through porous diffusers located at the bottom of the tank. As it bubbles to the surface, the diffused air provides oxygen and a rapid mixing action. Air can also be added by the churning action of mechanical propeller-like mixers located at the tank surface.

Under such oxygenated conditions, microorganisms thrive, forming an active, healthy suspension of biological solids—mostly bacteria—called activated sludge. About six hours of detention is provided in the aeration tank. This gives the microbes enough time to absorb dissolved organics from the sewage, reducing the BOD. The mixture then flows from the aeration tank into the secondary clarifier, where activated sludge settles out by gravity. Clear water is skimmed from the surface of the clarifier, disinfected, and discharged as secondary effluent. The sludge is pumped out from a hopper at the bottom of the tank. About 30 percent of the sludge is recirculated back into the aeration tank, where it is mixed with the primary effluent. This recirculation is a key feature of the activated sludge process. The recycled microbes are well acclimated to the sewage environment and readily metabolize the organic materials in the primary effluent. The remaining 70 percent of the secondary sludge must be treated and disposed of in an acceptable manner (see Sludge treatment and disposal).

Variations of the activated sludge process include extended aeration, contact stabilization, and high-purity oxygen aeration. Extended aeration and contact stabilization systems omit the primary settling step. They are efficient for treating small sewage flows from motels, schools, and other relatively isolated wastewater sources. Both of these treatments are usually provided in prefabricated steel tanks called package plants. Oxygen aeration systems mix pure oxygen with activated sludge. A richer concentration of oxygen allows the aeration time to be shortened from six to two hours, reducing the required tank volume.

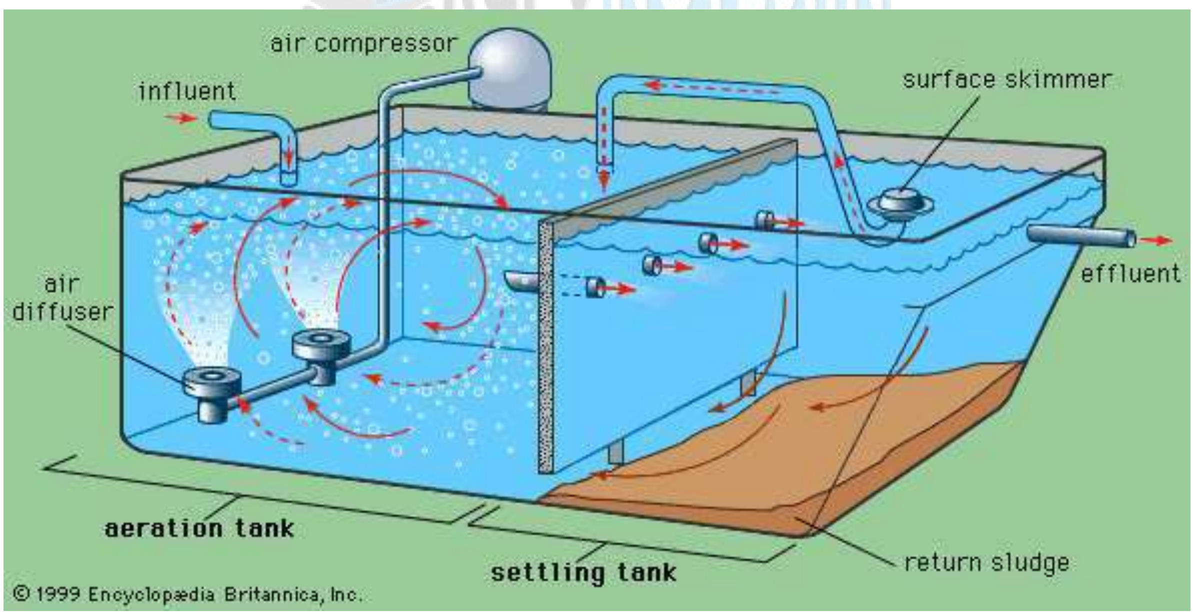


Figure: Schematic diagram of a prefabricated package plant for the aeration treatment of small sewage flows.

C. Oxidation pond:

Oxidation ponds, also called lagoons or stabilization ponds are large, shallow ponds designed to treat wastewater through the interaction of sunlight, bacteria, and algae. Algae grow using energy from the sun and carbon dioxide and inorganic compounds released by bacteria in water. During the process of photosynthesis, the algae release oxygen needed by aerobic bacteria. Mechanical aerators are sometimes installed to supply yet more oxygen, thereby reducing the required size of the pond. Sludge deposits in the pond must eventually be removed by dredging. Algae remaining in the pond effluent can be removed by filtration or by a combination of chemical treatment and settling.

Rotating biological contactor:

In this treatment system a series of large plastic disks mounted on a horizontal shaft are partially submerged in primary effluent. As the shaft rotates, the disks are exposed alternately to air and wastewater, allowing a layer of bacteria to grow on the disks and to metabolize the organics in the wastewater.

Tertiary treatment:

When the intended receiving water is very vulnerable to the effects of pollution, secondary effluent may be treated further by several tertiary processes.

Effluent polishing

For the removal of additional suspended solids and BOD from secondary effluent, effluent polishing is an effective treatment. It is most often accomplished using granular media filters, much like the filters used to purify drinking water. Polishing filters are usually built as prefabricated units, with tanks placed directly above the filters for storing backwash water. Effluent polishing of wastewater may also be achieved using microstrainers of the type used in treating municipal water supplies.

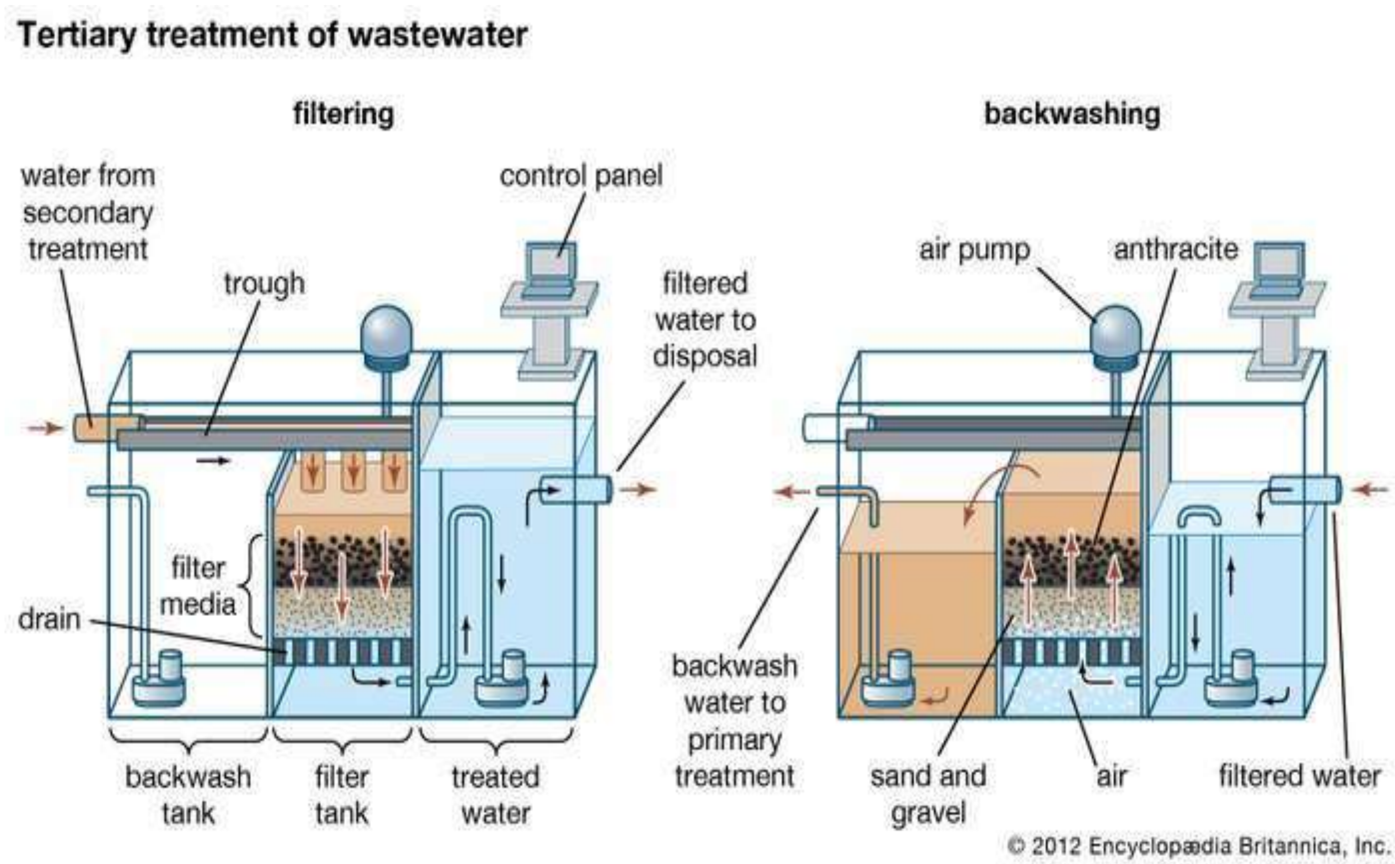


Figure: Tertiary treatment of wastewater.

Tertiary treatment of wastewater: During the filtering step, wastewater from secondary treatment, still containing suspended solids, pours from a trough and percolates through a filter bed made of porous media such as sand, gravel, and anthracite. The filtered water is then piped away for disposal. (Right) In the backwashing step, entrained solids are periodically flushed from the filter media by pumping filtered water back through the assembly. The backwash water, carrying suspended solids, is returned to the beginning of the wastewater treatment process.Encyclopædia Britannica, Inc.

Removal of plant nutrients

When treatment standards require the removal of plant nutrients from the sewage, it is often done as a tertiary step. Phosphorus in wastewater is usually present in the form of organic compounds and phosphates that can easily be removed by chemical precipitation. This process, however, increases the volume and weight of sludge. Nitrogen, another important plant nutrient, is present in sewage in the form of ammonia and nitrates. Ammonia is toxic to fish, and it also exerts an oxygen demand in receiving waters as it is converted to nitrates. Nitrates, like phosphates, promote the growth of algae and the eutrophication of lakes. A method called nitrification-denitrification can be used to remove the nitrates. It is a two-step biological process in which ammonia nitrogen is first converted into nitrates by microorganisms. The nitrates are further metabolized by another species of bacteria, forming nitrogen gas that escapes into the air. This process requires the construction of more aeration and settling tanks and significantly increases the cost of treatment.

A physicochemical process called ammonia stripping may be used to remove ammonia from sewage. Chemicals are added to convert ammonium ions into ammonia gas. The sewage is then cascaded down through a tower, allowing the gas to come out of solution and escape into the air. Stripping is less expensive than nitrification-gentrification, but it does not work very efficiently in cold weather.

Land treatment:

In some locations, secondary effluent can be applied directly to the ground and a polished effluent obtained by natural processes as the wastewater flows over vegetation and percolates through the soil. There are three types of land treatment: slow-rate, rapid infiltration, and overland flow.

In the slow-rate, or irrigation, method, effluent is applied onto the land by ridge-and-furrow spreading (in ditches) or by sprinkler systems. Most of the water and nutrients are absorbed by the roots of growing vegetation. In the rapid infiltration method, the wastewater is stored in large ponds called recharge basins. Most of it percolates to the groundwater, and very little is absorbed by vegetation. For this method to work, soils must be highly permeable. In overland flow, wastewater is sprayed onto an inclined vegetated terrace and slowly flows to a collection ditch. Purification is achieved by physical, chemical, and biological processes, and the collected water is usually discharged into a nearby stream.

Land treatment of sewage can provide moisture and nutrients for the growth of vegetation, such as corn or grain for animal feed. It also can recharge, or replenish, groundwater aquifers. Land treatment, in effect, allows sewage to be recycled for beneficial use. Large land areas are required, however, and the feasibility of this kind of treatment may be limited further by soil texture and climate.

Disposal:

The final destination of treated sewage sludge usually is the land. Dewatered sludge can be buried underground in a sanitary landfill. It also may be spread on agricultural land in order to make use of its value as a soil conditioner and fertilizer. Since sludge may contain toxic industrial chemicals, it is not spread on land where crops are grown for human consumption.

Where a suitable site for land disposal is not available, as in urban areas, sludge may be incinerated. Incineration completely evaporates the moisture and converts the organic solids into inert ash. The ash must be disposed of, but the reduced volume makes disposal more economical. Air pollution control is a very important consideration when sewage sludge is incinerated. Appropriate air-cleaning devices such as scrubbers and filters must be used.

