

# **Effects of Sewage Pollution on Aquatic Environment**

- **Physico-Chemical Characteristics**
- **Ecological Damage**
- **Health Risks**
- **Amenity Loss/Economic Loss**

# Physio-Chemical Characteristics

- The chemistry of water is greatly affected by organic pollution because of the accumulation of degradation products and decline in oxygen.
- The hypoxic conditions prevent the oxidation of ammonia and **hydrogen sulphide** formed after the degradation of organic matter, thus allowing their build up to dangerous levels.
- Organic pollution also increases the phosphorus content because it is released in the medium after decomposition. The build up of **CO<sub>2</sub> affects pH** and equilibrium in waters.

- The reduction in **pH and DO** modifies the redox potential that governs the movement of nutrients across the water and sediment interface.
- Large quantity of suspended sediments also gets settled at the bottom and promotes anaerobic conditions in the sediments.

# Ecological Damage

- Sewage is primarily organic in nature and therefore subject to bacterial decay. As a result of bacterial activity the oxygen concentration in the water is reduced, and sewage is said to have high biological oxygen demand.
- If the oxygen concentration falls **below 1.5 ppm**, the rate of aerobic oxidation is reduced and anaerobic bacteria start oxidizing organic molecules without oxygen.
- Decaying organic matter and nutrients in sewage enhance plant growth. Excessive algal growth and oxygen depletion can lead to alterations in ecosystem structure and to eutrophication.
- The dumping of sewage sludge at sea is another cause of ecological damage. Depending on the hydrography, sludge can smother the benthos, increase biomass, decrease species diversity and increase heavy metal concentration.

# Health Risks

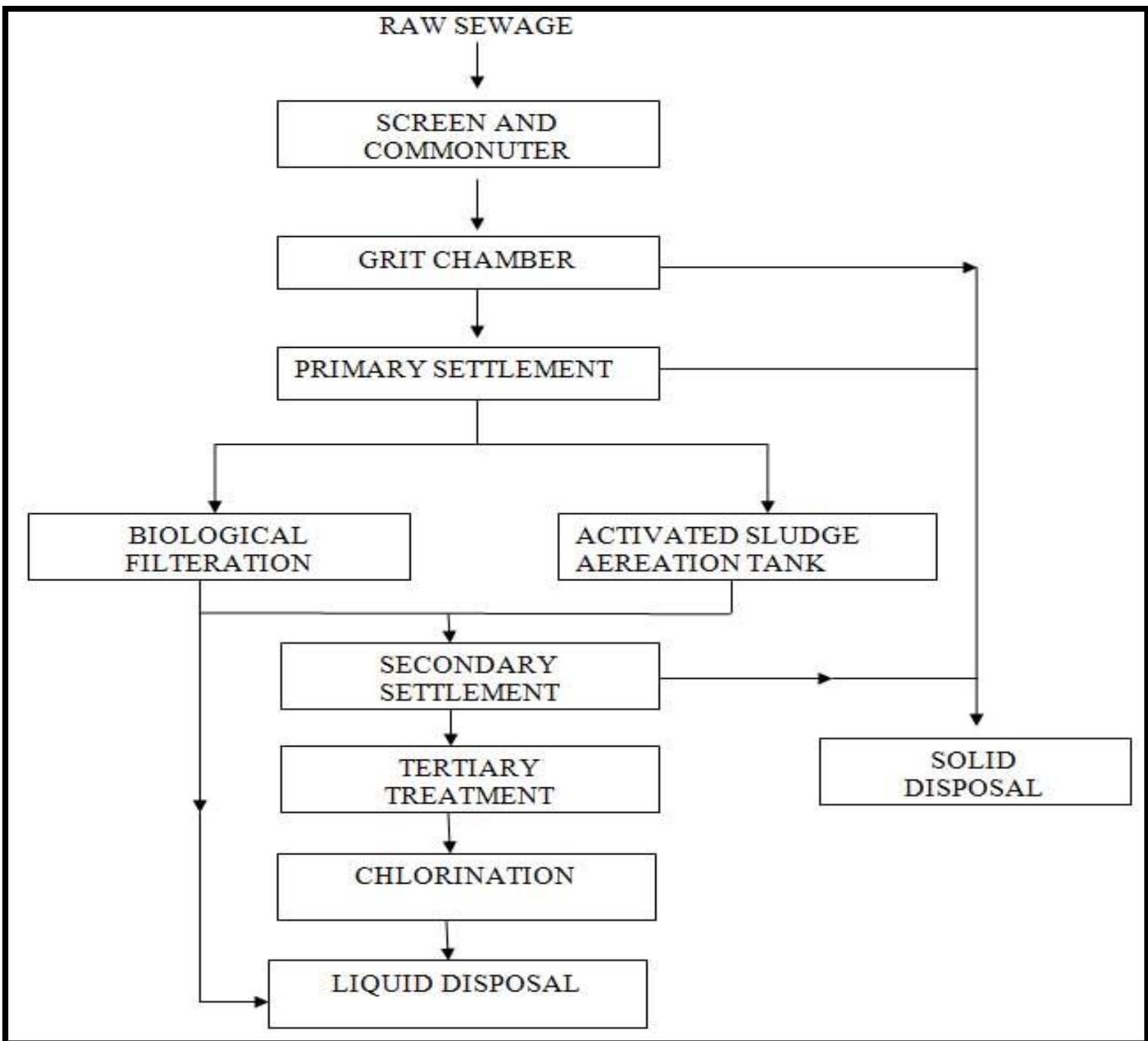
- There are a number of strains of bacteria and viruses that are found in raw sewage. Coliform bacteria are excreted by wild and domestic animals and also existing in the human gut.
- The greater the sewage contamination and exposure of people, the higher is the risk of contracting ear, nose and throat infection and stomach upsets such as gastroenteritis.
- Faecal streptococci are more closely associated with human sewage and their presence in a sample is believed to be a better indicator of sewage contamination than that of the coliforms.
- Faecal streptococci can cause illnesses, especially gastroenteritis. Other disease causing agents, which may be present in the sewage, include enteric viruses, Salmonella and the Hepatitis A virus.
- Shellfish grown in sewage contaminated waters may cause food poisoning as mussels and oysters accumulate human pathogens through their filter feeding apparatus.

# Amenity Loss/Economic Loss

- Debris associated with sewage probably has the highest monetary cost associated with its presence as our beaches, due to loss of tourism and blockage removal.
- Many people are becoming aware of the risks associated with sewage related debris and they may avoid beaches/recreational waters.
- Closure of shellfish beds due to contamination can lead to severe loss of income and closure of businesses.

# Sewage Treatment Methods

- Sewage treatment means removing organic and other oxygen demanding materials such as suspended solids, nutrients, fats, oil and grease and pathogens from the waste water so that the remaining waste water can be safely returned to the river or sea and become part of the natural cycle again.
- Sewage pollution can be reduced and avoided by the application of various levels of treatment. In sewage treatment solids are separated from liquids by physical processes and then the liquid is purified by biological processes.
- There are four possible stages in sewage treatment.
  - \* Preliminary treatment
  - \* Primary treatment
  - \* Secondary treatment
  - \* Tertiary treatment



# Preliminary Treatment

- The major aim of preliminary treatment is to remove the larger solid debris and floating materials (wood, paper rags and plastics).
- The waste is passed through screens consisting typically of parallel iron bars for the removal of floating objects (rags, plastics and wood). 'comminutor' or macerator is often provided for grinding the coarse material into smaller particles.
- A separate grit chamber is often provided where the waste is given retention for only a few minutes to settle down grit and other heavy materials.

# Primary Treatment

- This is a settlement process to remove suspended solids by passing the sewage through large settlement tanks where most of the solid materials sink to the bottom by gravity.
- The retention period of wastes in this tank may vary from 90-150 minutes which results in the removal of about 70% of the solids and 50% of the whole biological oxygen demand. The settled solids are referred as “sludge”.
- The sludge is used on farms after a further treatment called ‘sludge treatment’.

# Secondary Treatment

- It is a biological process, which relies on naturally occurring microorganisms acting to break down organic material and purify the liquid.
- The microorganisms are encouraged to grow on stones over which the sewage is trickled. A film of microbial growth develops on the filtering medium, which may be of 0.2-2.0 mm thick.
- The film consists of bacteria, fungi, protozoa and algae. The process can be speeded up by blowing air into the sewage tanks.

# Biological Treatment Units

- \* Trickling filters
- \* Percolating filters
- \* Activated sludge process
- \* Aerated lagoons
- \* Aerobic stabilization ponds
- \* Rotary biological contractor

# Trickling Filters

- A trickling filter consists of a bed of graded media such as stones, gravel, clinker, slag or even synthetic plastic material, with drains at the bottom to collect the treated waste.
- The waste is evenly distributed over the top surface of the bed with the help of a rotating arm or nozzles, from where it percolates down in the filter to the collecting drains.
- A film of microbial growth develops on the filtering medium, which may be of 0.2-2.0mm thick. The film consists of bacteria, fungi, protozoa and algae and commonly called as 'Zoological film' due to predominance of a bacterium, Zoogloea.
- As the waste trickles down over these microbial surfaces, the organic constituents of the waste are metabolized into more stable products.

# Tertiary Treatment

- If a high quality of effluent is required, it may be necessary to give further treatment. The aim of the tertiary treatment is 'polishing' the secondarily treated sewage to remove suspended solids and nutrients.
- The liquid derived from secondary treatment may be retained in sedimentation ponds or passed through sand or earth filters to remove suspended solids.
- To reduce plant nutrients (nitrogen and phosphorus), both chemical and biological methods can be employed.

- Phosphorus can be precipitated chemically as calcium phosphate by substances such as lime, ferrous/ferric chloride, sulphate alum, etc at pH above 11.
- $Al_2(SO_4)_3 + H_2PO_4 + 3H_2 \longrightarrow Al(OH)_3 + AlPO_4 + 3SO_4^{2-} + 4H_2O$
- Ammonia can also be stripped off the effluents. In air stripping of ammonia, the ammonium ions are converted into ammonia gas by increasing the pH, the gaseous ammonia is then removed into air by agitating the waste water.
- $NH_3 + H_2O \longrightarrow NH_4 + OH^-$

# Disinfections Treatment

- The treated sewage, however, may still contain some pathogenic organisms such as bacteria and viruses. This might affect the human population, if they are likely to be exposed to the effluent that is discharged, as in bathing waters.
- The disinfection can be achieved by the addition of strongly reactive chemicals such as chlorine, ozone, perchloric acid, etc.
- But these may react with the constituents of the effluent to yield potentially carcinogenic organochlorines.
- A safer alternative is to subject the waste to ultraviolet light or continuous microfiltration treatments.

# Utilization of wastes

- Irrigation
- Production of single cell proteins and biofertilizers
- Generation of biogas and energy
- Compost

# Pollutants

- There are two categories of pollutants
  - \* Dissolved solids and liquids
  - \* Suspended solids and liquids
- Most of the chemicals released in the effluents are generally soluble in water. They form aqueous solutions and therefore, cannot be separated by ordinary physical processes like screening, settling and filtration.

- Dissolved solids and liquids are removed from the wastes following one of the following methods.
  - \* Neutralization
  - \* Oxidation
  - \* Reduction
  - \* Reverse osmosis
  - \* Ion-exchange
  - \* Carbon adsorption
  - \* Phenol destruction
  - \* Evaporative stripping.

- The suspended solids and liquids are removed by
  - \* Filtration
  - \* Sedimentation
  - \* Floatation
  - \* Flocculation
  - \* Centrifugation
  - \* Incineration
  - \* Oil- water separation