



## Wastewater Treatment

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Wastewater treatment is a crucial environmental management process that involves the removal of contaminants from used water generated by households, industries, agriculture, and storm runoff. This used water, commonly referred to as sewage, contains a mixture of organic and inorganic substances, nutrients, suspended solids, and pathogenic microorganisms. If discharged untreated, it can cause severe environmental pollution, waterborne diseases, and ecosystem imbalance (Dhote *et al.*, 2012). Therefore, wastewater treatment is essential to make water safe for discharge into natural water bodies or for reuse.

### Types of Waste water

Wastewater is generated from various sources:

#### 1. Domestic Wastewater:

This includes wastewater from households, institutions, and commercial establishments. It is classified into Blackwater Wastewater from toilets containing human excreta. Greywater Wastewater from kitchens, bathrooms, and laundry (Crini, and Lichtfouse, 2019).

#### 2. Industrial Wastewater:

Industries generate wastewater containing chemicals, heavy metals, dyes, oils, and other toxic substances. The composition varies depending on the type of industry (Wong and Chu 2013)

#### 3. Agricultural Wastewater:

It originates from irrigation runoff and contains fertilizers, pesticides, animal wastes, and soil particles. This is often a major source of non-point pollution.

#### 4. Stormwater Runoff

Rainwater flowing over land surfaces collects pollutants such as dust, plastics, oil, and agrochemicals before entering drainage systems.

### Characteristics of Wastewater

Wastewater characteristics are broadly classified into physical, chemical, and biological properties:

#### 1. Physical Characteristics

**Colour:** Fresh wastewater is light grey, but it turns dark grey or black under anaerobic conditions due to decomposition.

**Odour:** Initially mild but becomes foul as organic matter decomposes.

**Temperature:** Higher than freshwater due to domestic and industrial heat inputs.

**Turbidity:** Indicates the presence of suspended and colloidal particles.

**Total Solids:** Includes suspended solids, dissolved solids, and settleable solids.

#### 2. Chemical Characteristics

**Organic Matter:** Includes proteins, carbohydrates, fats, and oils derived from plant and animal sources.

**Biochemical Oxygen Demand (BOD):** A key indicator of organic pollution, representing the amount of oxygen required by microorganisms to decompose organic matter.

**Chemical Oxygen Demand (COD):** Measures total oxygen required to oxidize both biodegradable and non-biodegradable substances.

**Inorganic Substances:** Includes minerals, salts, metals, and toxic chemicals that are often difficult to degrade.

### 3. Biological Characteristics

**Bacteria:** Present in large numbers; responsible for decomposition of organic matter. Some are pathogenic.

**Protozoa:** Feed on bacteria and help in purification.

**Viruses:** Cause diseases such as hepatitis and polio.

**Fungi:** Decompose complex organic materials like cellulose and lignin.

## Wastewater Treatment Processes

Wastewater treatment involves a combination of physical, chemical, and biological processes carried out in stages:

### 1. Primary Treatment (Physical Processes)

This stage focuses on removing large solids and suspended materials.

**Screening:** Wastewater passes through screens that remove large debris such as plastics, rags, and sticks.

**Grit Removal:** Sand, gravel, and other heavy particles are removed in grit chambers.

**Grinding:** Large solids are broken down into smaller particles.

**Sedimentation:** Wastewater is allowed to stand in tanks so that heavier suspended solids settle at the bottom as sludge, while lighter materials float on the surface.

**Flotation:** Air is introduced to remove lighter suspended particles.

This stage removes about 50–60% of suspended solids (Seow *et al.*, 2016)

### 2. Secondary Treatment (Biological Processes)

Secondary treatment aims to remove dissolved and biodegradable organic matter using microorganisms. (Sonune and Ghate 2004).

**Activated Sludge Process:** Wastewater is aerated in tanks to promote the growth of microorganisms that form flocs and consume organic matter. The advantages of the process It provides well clarified effluent.

**Trickling Filters:** Wastewater is passed over a bed of stones or plastic media coated with microbial films that degrade organic pollutants. The advantages of the process flocs settle as sludge and are removed (Raouf *et al.*, 2019)

**Oxidation Ponds:** Large shallow ponds where natural processes involving sunlight, algae, and bacteria degrade organic matter over time.

### 3. Tertiary Treatment (Advanced Treatment)

This is the final stage, used to remove remaining impurities, nutrients, and pathogens.

**Reverse Osmosis:** Water is forced through a semipermeable membrane to remove dissolved salts and impurities.

**Ion Exchange:** Removes unwanted ions such as calcium, magnesium, nitrates, and sulfates by replacing them with harmless ions.

**Electrodialysis:** Uses an electric field to separate ions through selective membranes.

Tertiary treatment ensures the water is safe for reuse or discharge into sensitive ecosystems.

## Small-Scale Wastewater Treatment Systems

In rural or individual household settings, simpler systems are used:

**Septic Tank:** Works on anaerobic digestion where solids settle and decompose.

**Imhoff Tank:** A two-chamber system for sedimentation and digestion.

**Cesspool:** A pit that collects and partially filters wastewater into the soil.

## Conclusion

Wastewater treatment is essential for protecting environmental and public health. It removes harmful pollutants from water generated by domestic, industrial, and agricultural activities. The treatment process includes primary, secondary, and tertiary stages for effective

purification. It helps prevent water pollution and supports aquatic ecosystems. Treated water can be reused, conserving valuable water resources. Therefore, wastewater treatment is vital for sustainable development and a healthy future.

## References

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