International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

SEWAGE TREATMENT PLANT (STP)

Mr. Aman Mishra[1], Mr. Vinod Kumar[2], Mr. Avinash Singh[3], Mr. Archit Sachan[4], Prof. Shubhendu Mishra[5]

[1,2,3,4]Student, Civil Engineering, GITM
[5]Professor, Civil Engineering, GITM

CHAPTER 1 – INTRODUCTION

1.1 What is Sewage

Sewage is wastewater generated from households, industries, commercial buildings, and rainwater.
It contains:

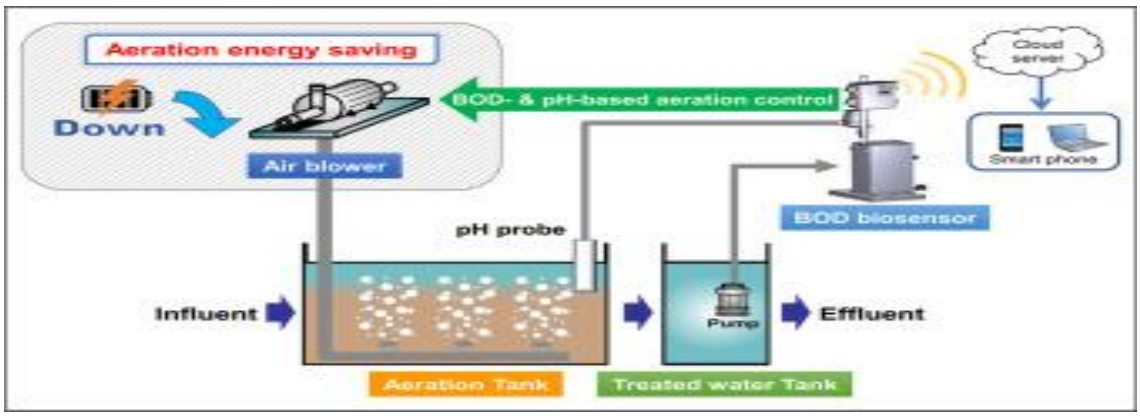
- Organic matter
- Suspended solids
- Microorganisms
- Oils & grease
- Chemicals

1.2 What is Sewage Treatment Plant (STP)

A Sewage Treatment Plant is an engineered system designed to treat wastewater before releasing it into the environment.
Its purpose is to remove:

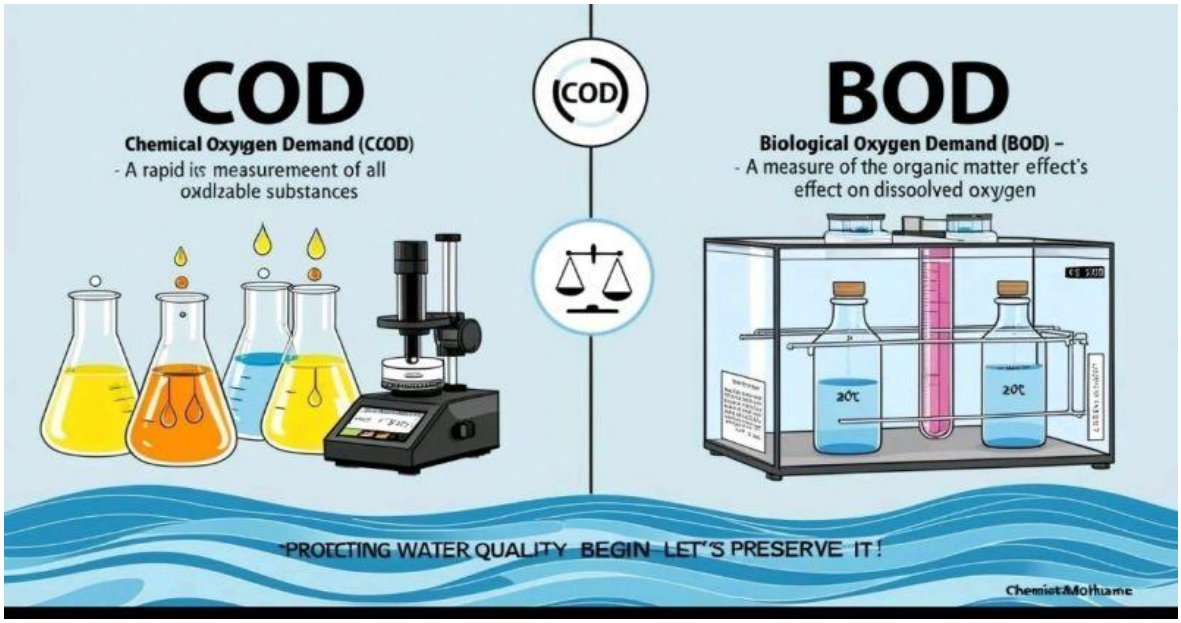
- ❖ BOD (Biochemical Oxygen Demand)

  Biochemical Oxygen Demand (BOD) measures the oxygen microorganisms use to break down organic matter in water, indicating water quality and pollution levels.



- ❖ COD (Chemical Oxygen Demand)

Chemical Oxygen Demand (COD) measures the oxygen needed to chemically oxidize all organic and inorganic matter in water.



- ❖ Suspended solids

Suspended solids (SS) are tiny organic or inorganic particles (like silt, algae, debris) floating in water, making it cloudy (turbid) and affecting aquatic life by blocking sunlight and lowering oxygen. Measured

- ❖ Pathogens

1.3 **Need for STP**

- Prevent water pollution
- Safe disposal of wastewater
- Reduce diseases
- Protect rivers, lakes & groundwater
- Reuse for gardening, irrigation, construction
- 1.4 Objectives of Project

- ❖ To study sewage characteristics
- ❖ To design a functional STP
- ❖ To reduce BOD/COD to a safe limit
- ❖ To ensure environmental sustainability

CHAPTER 2 – LITERATURE REVIEW

2.1 Previous Research

Researchers have studied wastewater treatment using:

- Conventional Activated Sludge

- MBBR - (Moving Bed Biofilm Reactor) is an advanced biological sewage treatment process using free-floating plastic media (carriers) in an aeration tank, creating a large surface area for biofilms (microbes) to break down pollutants efficiently, combining suspended and attached growth for high performance, small footprint, and easy upgrades to existing plants without sludge recycling. Key features include high treatment efficiency for organics, nitrogen, and phosphorus, resistance to shock loads, lower sludge production, and adaptability for various flow rates.

- SBR - Very good BOD, COD, and nutrient (nitrogen, phosphorus) removal, as its batch operation allows for tailored cycles.

- MBR - **Highest** efficiency, consistently producing superior quality effluent (low TSS, BOD, COD, and color) suitable for direct water reuse due to membrane filtration.

2.2 STP Requirements by CPCB

1. CPCB standards:
2. BOD < 10 mg/L
3. COD < 50 mg/L
4. Suspended Solids < 20 mg/L

CPCB (Central Pollution Control Board) requirements for Sewage Treatment Plants (STPs) mandate strict discharge limits for treated water, focusing on parameters like pH, BOD, COD, Total Suspended Solids (TSS), Nitrogen (Ammoniac & Total), and Fecal Coliform, with key norms being **pH 6.5-8.5, BOD ≤ 10 mg/L, COD ≤ 50 mg/L, TSS ≤ 10 mg/L, Ammoniac N ≤ 5 mg/L, Total N ≤ 5 mg/L, and Fecal Coliform ≤ 100 MPN/100 mL**, along with requirements for infrastructure, real-time monitoring, and mandatory water reuse for hospitals and new plants

2.3 International Guidelines

WHO recommends:
pathogen-free wastewater

reuse in irrigation
advanced disinfection

WHO guidelines for public health, International Council of Ophthalmology (ICO) for eye care, International Working Group on Diabetic Foot (IWGDF) for foot ulcers, ICH for pharmaceutical standards, International Headache Society (IHS) for headache management.

2.4 Recent Technologies

- Io T monitoring
- SCADA automation
- Solar-powered aeration
- Biological nutrient removal
- This literature indicates that modern STPs must be efficient, low-energy, and automated.

CHAPTER 3 – METHODOLOGY

3.1 Steps of Sewage Treatment

STP works in the following stages:
(A) Preliminary Treatment
Screens (removes plastics, clothes)
Grit Chamber (removes sand & stones)
(B) Primary Treatment

Primary Clarifier

* Solids settle at the bottom
* Removes 30–40% organic load

(C) Secondary Treatment

Biological Treatment

Options:

Activated Sludge Process (ASP)

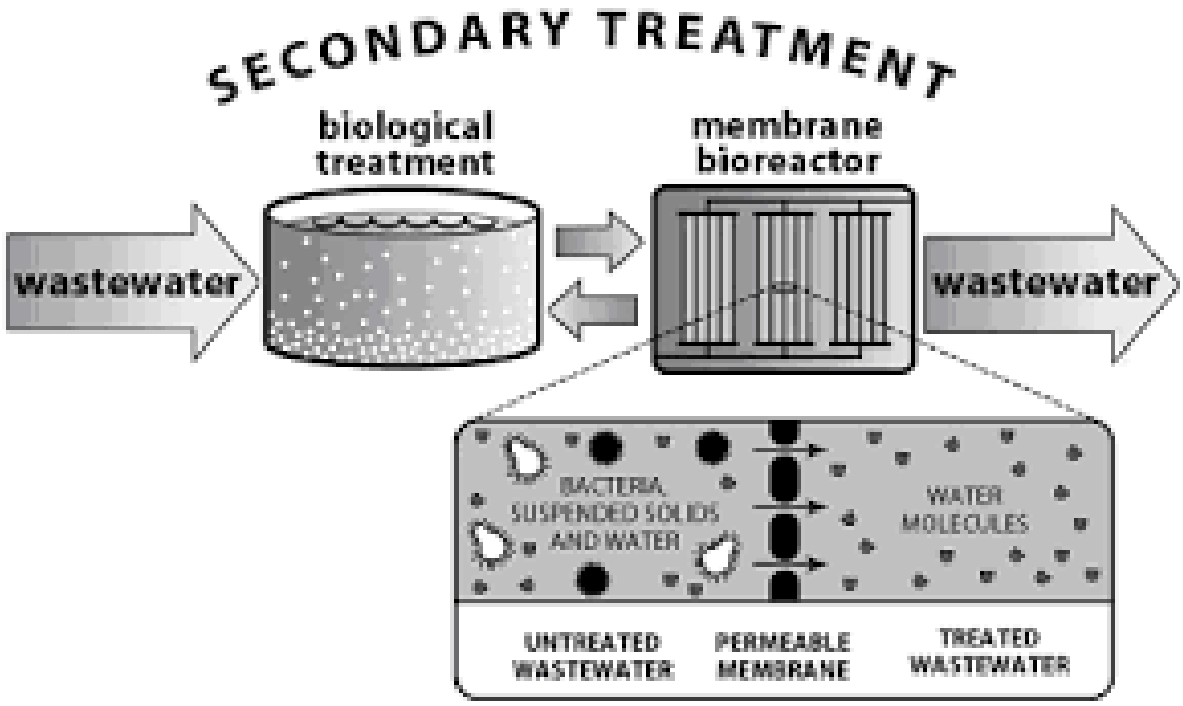
SBR

MBBR

Aeration provides oxygen to microorganisms, which break down the waste.

Secondary Clarifier

* Settles biological sludge

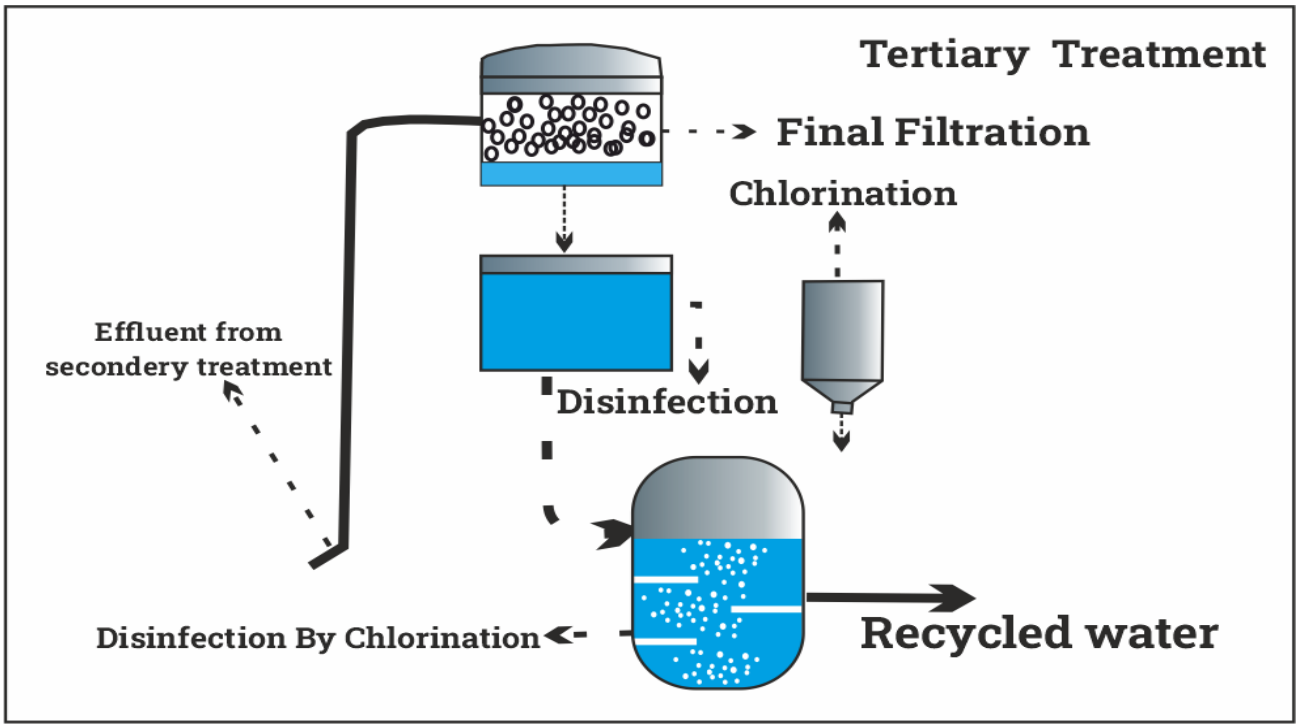


(D) Tertiary Treatment

Filtration

Disinfection (Chlorine/UV/Ozone)

Activated Carbon Treatment



(E) Sludge Treatment

Thickening
Digestion
Dewatering
Drying

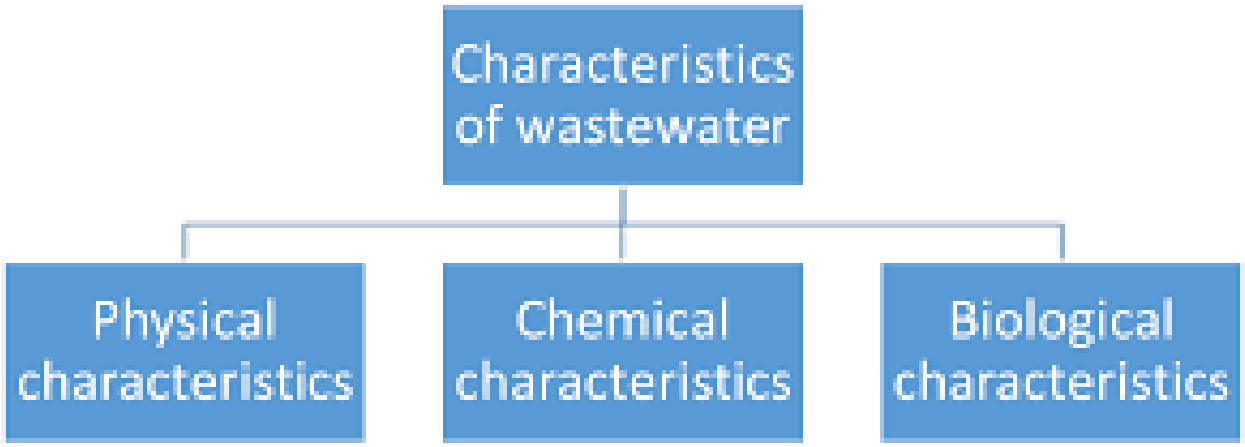
3.2 Water Quality Testing

- Parameters analyzed:
- pH
- BOD
- COD
- Total Suspended Solids
- Ammonia & Nitrates

CHAPTER 4 – ANALYSIS OF SEWAGE

4.1 Characteristics of Raw Sewage

- Physical
- Color: gray/black
- Odor: foul
- Temperature: 20–28°C
- Chemical
- BOD: 200–300 mg/L
- COD: 400–600 mg/L
- pH: 6.5–8.5
- Chlorides: moderate
- Biological
- Bacteria
- Viruses
- Protozoa



4.2 Results & Interpretation

- Analysis shows the sewage requires:
- Strong biological treatment
- Proper aeration
- Final polishing

CHAPTER 5 – DESIGN & IMPLEMENTATION

5.1 STP Capacity

Example:
For population 5,000
Sewage = 135 LPCD
→ Total = 6,75,000 liters/day
= 0.675 MLD STP

5.2 Unit Design

- **Screening chamber**

An STP (Sewage Treatment Plant) Screen Chamber is the crucial first step, a channel with screens (bar racks) to catch large debris (rags, plastics, etc.) protecting downstream equipment like pumps, featuring specific depths, flow velocities (e.g., 0.3-0.9 m/s), bar spacing (20-50mm), and often a grit removal section below

- **Grit chamber**

A grit chamber in wastewater treatment is a basin that slows sewage flow to remove heavy inorganic materials like sand, gravel, and eggshells (grit) before they damage pumps and other equipment or accumulate in digesters, using principles like controlled velocity and specific gravity to let grit settle while keeping lighter organic solids in suspension for downstream treatment.

- **Equalization tank**

a crucial first stage buffer tank that collects fluctuating raw sewage, smooths out variations in flow rate and pollutant strength (like peak hours), and releases it at a steady, consistent rate for efficient downstream treatment, often using air mixing for homogeneity and to start biological processes. It stores excess sewage during high inflow times

- **Aeration tank**

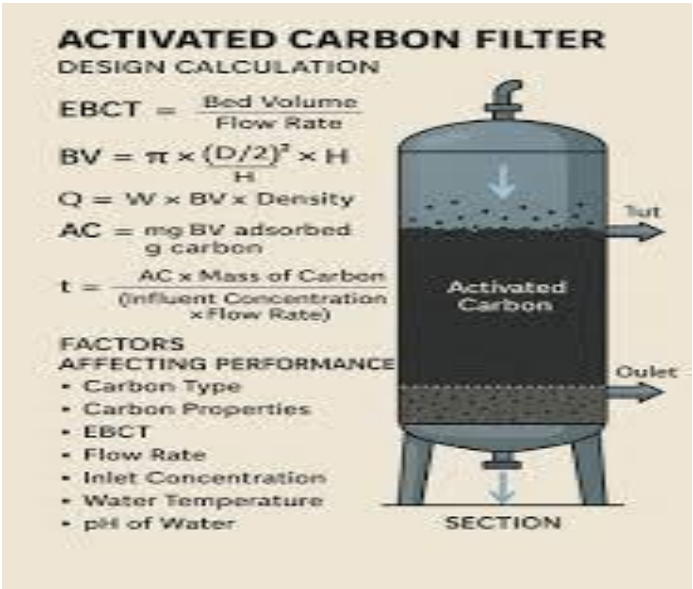
An STP (Sewage Treatment Plant) Aeration Tank is the core biological treatment unit where air is pumped into wastewater to fuel aerobic microbes, which consume organic pollutants, reducing BOD and making water cleaner for subsequent treatment stages like clarification and disinfection, essentially the heart of the activated sludge process.

- **Pressure sand filter**

A Pressure Sand Filter (PSF) in an STP (Sewage Treatment Plant) is a crucial unit that uses layers of graded sand/media within a pressure vessel to physically remove turbidity, suspended solids, and particles from wastewater, producing clearer water for reuse or further treatment by passing it under pressure downwards through the filter bed

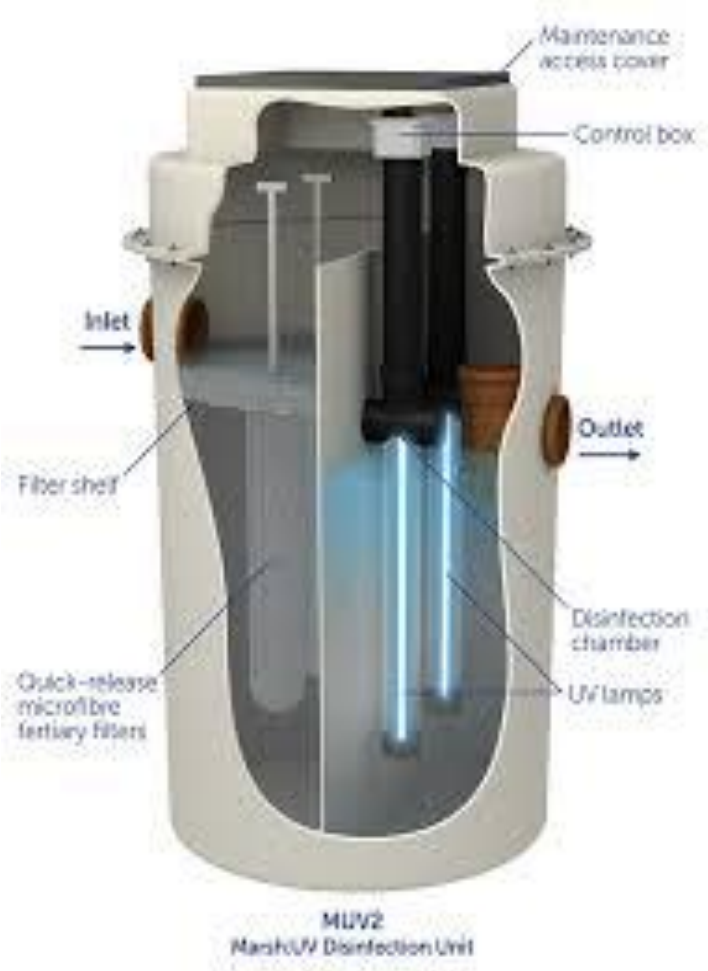
- **Activated carbon filter**

Activated Carbon Filters (ACFs) are vital in Sewage Treatment Plants (STPs) for post-treatment polishing, using adsorption to remove lingering organic compounds, chlorine, bad tastes, odors, and colors, ensuring the final effluent meets strict discharge standards or is suitable for reuse



- **Disinfection chamber**

  Disinfection Chamber is the final stage in wastewater treatment, using agents like chlorine, UV light, or ozone to kill remaining harmful microbes (pathogens) in treated water, making it safe for discharge or reuse, preventing waterborne diseases, and ensuring environmental compliance.



- **Sludge drying bed**

  A low-cost, natural system using layers of sand/gravel and gravity/solar energy to dewater sludge, separating water from solids, reducing volume, and preparing it for disposal or use (like fertilizer), often serving smaller plants by filtering liquid back to the plant and leaving dry solids.

5.3 Materials Used

- RCC tanks
- PVC/HDPE pipes
- Blowers & diffusers
- Pumps
- Control panel

5.4 Automation

SCADA system
Io T sensors
DO monitoring Flow meters

CHAPTER 6 – EVALUATION & PERFORMANCE

6.1 Testing Treated Water

After treatment:

- BOD < 10 mg/L
- COD < 30–50 mg/L
- Turbidity < 10 NTU
- 6.2 System Efficiency
- Energy use: moderate
- Sludge generation: low
- Removal efficiency:
- BOD: 90%
- COD: 85–90%
- SS: 95%

6.3 Maintenance

- Regular cleaning
- Filter backwashing
- Periodic sludge removal
  Periodic sludge removal is a critical maintenance task in a Sewage Treatment Plant (STP) that involves extracting accumulated semi-solid material (sludge) from settling tanks for further processing and safe disposal or reuse. This process is essential for maintaining operational efficiency and complying with environmental regulations
- Aerator servicing

Aerator Servicing involves deep maintenance of blowers and diffusers in Sewage Treatment Plants, focusing on inspection, cleaning (filters, silencers), lubrication (bearings), checking electrical, and performance testing (airflow, vibration,

CHAPTER 7 – COST ESTIMATION

7.1 Capital Cost

- Includes:
- Civil construction

  STP civil work refers to the essential civil engineering aspects of building a Sewage Treatment Plant, involving excavation, foundations, reinforced concrete structures (tanks, chambers), piping, and site development to house the physical and biological processes that treat wastewater for safe reuse or discharge, ensuring compliance with environmental standards for residential, commercial, and industrial needs.

- Mechanical equipment

  Sewage Treatment Plant (STP), involving pumps, screens, aerators, clarifiers, filters, and sludge handling systems that physically and mechanically clean wastewater, working alongside chemical processes to remove solids, organic matter, and pathogens, crucial for environmental compliance and water reuse

- Electrical works
  Signing, installing, and connecting power to pumps, blowers, control panels, and monitoring systems,

- Installation
- **Site Evaluation & Design**: Assess soil, groundwater, and sewage volume to select the right technology (e.g., packaged, modular) and size (KLD - kiloliters per day).
- **Permits & Approvals**: Secure necessary clearances from local authorities, ensuring compliance with environmental norms.
- **Site Preparation & Foundation**: Excavate the area and build a stable base for the tanks and equipment.
- **Component Installation**: Place tanks, pumps, aerators, screens, and control panels according to the design, using manufacturer guidelines.
- **Plumbing & Electrical**: Connect pipes and wire electrical systems for pumps and controls, performed by qualified personnel.
- **Testing & Commissioning**: Stringently test all components and the entire system to ensure it functions correctly and meets quality standards.
- **Operator Training**: Train staff to monitor, maintain, and manage the plant effectively.

- For 1 MLD STP → ₹1.5 to ₹3 Crore

→ Approx. ₹6–12 lakh per year

CONCLUSION

The sewage treatment plant successfully treats wastewater to meet environmental standards. It protects water bodies, supports public health, and promotes sustainable water reuse. The designed STP ensures high removal efficiency and low operational cost, making it suitable for urban and rural applications.