Water Supply & Sanitary Engineering (DI05006021)

Unit 3: Treatment of Water

Lecture 8: Objects, Location, and Layout of Water Treatment Plants

GTU Diploma Engineering

Lecture Agenda

- Need for Water Treatment
- Primary Objectives of Treatment
- Principles of Water Purification
- Site Selection for Water Treatment Plants
- Typical Layout and Flow Diagram
- Overview of Unit Operations

The Need for Water Treatment

- Raw water from natural sources (rivers, lakes, groundwater) is rarely pure enough for direct consumption.
- Surface water often contains suspended solids, organic matter, and pathogenic microorganisms.
- Groundwater may contain dissolved minerals, hardness, iron, or manganese.
- Treatment is mandatory to bridge the gap between raw water quality and statutory drinking water standards.

Objectives of Water Treatment (Part 1)

- Public Health Protection: Removal or inactivation of pathogenic organisms (bacteria, viruses, protozoa) to prevent waterborne diseases like cholera and typhoid.
- Aesthetic Improvement: Removal of turbidity (suspended solids), color, taste, and odor to make water visually appealing and palatable.
- Chemical Safety: Reduction of toxic chemicals, heavy metals, and harmful organic compounds to safe limits.

Objectives of Water Treatment (Part 2)

- Corrosion Control: Preventing water from being too acidic or corrosive to protect the distribution pipes and plumbing fixtures.
- Scale Prevention: Managing water hardness to prevent scale formation in boilers, pipes, and household appliances.
- Industrial Suitability: Providing water that meets the specific quality requirements of local industries (e.g., textiles, food processing).

Principles of Water Treatment

- Physical Processes: Rely on physical forces. Examples include screening (physical barrier), aeration (gas transfer), and sedimentation (gravity settling).
- Chemical Processes: Involve chemical reactions to alter impurities. Examples include coagulation (destabilizing particles) and disinfection (oxidizing pathogens).
- Biological Processes: Rarely used for primary municipal water supply but common in wastewater; utilizes microorganisms to consume organics.
- A typical water treatment plant combines physical and chemical processes sequentially.

Location of a Water Treatment Plant

- Proximity to Water Source: The plant should be as close to the raw water source as practical to minimize the cost of large raw water transmission mains.
- Proximity to City/Demand Center: Balancing source distance with distance to the distribution network to reduce pumping costs for treated water.
- Topography: Ideally located on elevated ground to allow gravity flow of treated water to the city distribution system.

Additional Site Selection Criteria

- Availability of Land: Sufficient land area must be available for present plant construction and future expansion (typically 10-30 years ahead).
- Flood Protection: The site must be above the highest flood level (HFL) of the nearby river or water body to ensure uninterrupted operation during monsoons.
- Soil Bearing Capacity: Firm soil is required to support the massive weight of concrete water-retaining structures.
- Accessibility: Good road connectivity for transporting heavy equipment, daily chemical supplies (like alum and chlorine), and personnel.

Typical Layout of a Treatment Plant

- Sequential Flow: Units are arranged so water flows logically from one stage to the next, preferably by gravity.
- Compact Design: Units should be closely spaced to minimize interconnecting pipework, reducing head loss and cost.
- Bypass Arrangements: Every unit should have a bypass line and parallel duplication to allow maintenance without shutting down the entire plant.
- Administrative and Chemical Buildings: Located centrally or near the entrance for easy access and chemical dosing.

Flow Diagram of Conventional Treatment

- Raw Water Intake -¿ Screens
- Screens -¿ Aeration (Optional)
- Aeration -¿ Coagulation/Rapid Mix
- Rapid Mix -¿ Flocculation
- Flocculation -¿ Sedimentation Clarifiers
- Sedimentation -¿ Rapid Sand Filters
- Filters -¿ Disinfection (Chlorination)
- Disinfection -¿ Clear Water Reservoir (CWR)

Overview of Unit Operations

- Screening: Removes large floating debris (leaves, branches).
- Aeration: Removes dissolved gases (CO2, H2S) and oxidizes iron/manganese.
- Coagulation & Flocculation: Clumps together microscopic colloidal particles into larger flocs.
- Sedimentation: Settles out the heavy flocs via gravity.
- Filtration: Removes remaining fine suspended matter and bacteria.
- Disinfection: Kills remaining pathogenic microorganisms.

Summary and Next Steps

- Water treatment is essential for public health, aesthetics, and protecting infrastructure.
- Plant location relies on topography, proximity to source/city, and flood protection.
- Conventional treatment involves screening, coagulation, sedimentation, filtration, and disinfection.
- Next Lecture: We will dive deep into the first major chemical processes: Coagulation and Flocculation.