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- **References:**

1. World Health Organization (WHO) –

"Guiding Principles for Drinking Water Quality."

2. United States Environmental Protection Agency (EPA) –

"Water Treatment Standards."

3. Reports from the World Bank on water resource management.

4. Recent research in scientific journals such as:

Water Research and Journal of Environmental Engineering.



## ❖ 1\_Introduction :

Water is the essence of life, and no living being can survive without it. It plays a vital role in all aspects of life, including drinking, food, hygiene, agriculture, and industry. Although about 71% of the Earth's surface is covered with water, only around 3% of it is fresh water suitable for consumption, and only a small portion of that is directly accessible for use. With the increasing population and industrial and agricultural development, water sources have experienced growing pollution due to the discharge of wastewater, industrial waste, and chemical pesticides. This has led to the deterioration of water quality and negatively impacted human health and the environment. Therefore, water purification has become a necessary process to remove pollutants and harmful substances from water, making it safe for drinking or other uses. This process includes a series of steps and techniques that vary depending on the source of the water and the type of contaminants present.

## ❖ 2\_STAGES OF WATER Treatment :

### 1. Preliminary Treatment (Screening and Sedimentation):

In this stage, large solid materials and debris are removed to prevent damage to the equipment and improve the efficiency of the next steps:

- Items like leaves, branches, plastic waste, gravel, and sand are filtered out.
- Metal screens or grates are used to trap large objects.
- Water is then passed into sedimentation basins, where heavier particles settle at the bottom over time.

The main goal is to ease the load on subsequent treatment processes and ensure smoother operation.

### 2. Chemical Treatment (Coagulation and Flocculation):

This step removes fine particles that cannot be easily settled:

- Chemicals such as **alum (aluminum sulfate)** or **ferric chloride** are added to the water.
- These chemicals bind with small particles and form larger clumps known as **flocs**.



- The water is gently mixed to allow the flocs to grow in size without breaking.
- Once formed, the flocs are allowed to settle in secondary sedimentation tanks.

This stage significantly reduces turbidity and removes a large portion of organic and inorganic matter.

### 3. Filtration:

Now that most solids have been removed, the water goes through filtration to catch any remaining impurities:

- Filters usually consist of **layers of fine sand, gravel, and sometimes activated carbon**.
- Sand captures fine particles, while activated carbon absorbs organic substances, odors, and some chemical pollutants.
- This step ensures that the water becomes nearly free of suspended particles.

Filters must be cleaned regularly to maintain performance.

### 4. Disinfection (Sterilization):

Even after filtration, harmful microorganisms may still be present, so disinfection is critical:

- **Chlorine** is the most commonly used disinfectant due to its effectiveness, low cost, and residual protection throughout water distribution.
- Modern plants may also use **ultraviolet (UV) light** or **ozone** as alternative disinfection methods.
- This stage kills or neutralizes bacteria, viruses, and pathogens that could cause waterborne diseases like cholera, typhoid, or dysentery.

### 5. Advanced Treatment (Optional):

In special cases—such as desalination or treating heavily polluted water—additional steps may be applied:

- **Reverse Osmosis (RO):** A membrane-based process that removes dissolved salts and heavy metals.
- **Activated Carbon Adsorption:** Removes specific organic compounds responsible for taste, odor, or chemical contamination.



- **Biological Treatment:** Uses beneficial microorganisms to break down organic matter, especially useful in wastewater treatment.

### ❖ **3\_Importance of Water Treatment:**

Water treatment is an essential process to ensure the availability of clean and safe water for various uses. Its importance can be summarized as follows:

#### **1. Protecting Public Health:**

Water treatment removes impurities and pathogens that can cause serious diseases such as cholera, typhoid, and food poisoning. Without proper treatment, water becomes a major source of epidemics.

#### **2.Environmental Protection:**

Untreated wastewater discharged into rivers or seas harms ecosystems and negatively affects plant and animal life. Treatment helps preserve the natural environment

#### **3. Sustainable Resource Management:**

Treating and reusing water, especially wastewater, reduces the pressure on freshwater sources and supports sustainable water management.

#### **4.Supporting Economic Development:**

Clean water is essential for agriculture, industry, and tourism. Water treatment ensures a steady and safe supply, which is key for economic growth in various sectors

#### **5. Reducing Healthcare Costs:**

The cleaner the water, the lower the risk of disease spread, which reduces medical expenses for individuals and governments alike

### ❖ **4\_Types of Water Treatment Plants:**

Water treatment plants vary depending on the type of water being treated and the intended use. The main types include:

#### **1. Drinking Water Treatment Plants:**



These plants treat natural water from rivers, lakes, or wells to make it safe for human consumption. They focus on removing impurities, bacteria, and harmful chemicals to produce potable water

## 2. Wastewater Treatment Plants:

These treat contaminated water from domestic or industrial use before releasing it back into the environment or reusing it. Wastewater requires more complex treatment processes due to its high pollution levels

## 3. Desalination Plants:

Used mainly in areas with limited freshwater resources, such as coastal or desert regions. These plants rely on technologies like **reverse osmosis** to remove salts from seawater or brackish water and make it suitable for use.

## ❖ 5\_Challenges Facing Water Treatment:

- High operational costs.
- Lack of resources and funding in some developing countries.
- Need for training and development of technical personnel.
- Climate change and its impact on water resources.

## ❖ 6\_Conclusion:

Water treatment is not an option but an urgent necessity to ensure a safe water future for upcoming generations. Investing in water treatment technologies and raising awareness of its importance are among the key steps toward sustainable development and the preservation of this vital resource. It is everyone's responsibility—individuals and institutions alike—to work together to protect water and use it wisely.