Drinking Water Treatment: Disinfection

Disinfection is the final and most critical step in drinking water treatment, designed to eliminate pathogenic microorganisms such as bacteria, viruses, and protozoa.
Even after coagulation,flocculation,sedimentation,andfiltration, some microorganisms may remain. Disinfection ensures that water is microbiologically safe for human consumption.
The process may involve the use of chemical agents(e.g.,chlorine,ozone)or physical methods (e.g., UV radiation, heat) to destroy pathogens.

1. Objectives of Disinfection

- To eliminate disease-causing microorganisms(bacteria,viruses,protozoa).
- To prevent the outbreak of waterborne diseases such as cholera,typhoid,anddysentery.
- To provide residual protection in distribution systems (chlorination).
- To meet national and international drinking water quality standards.

2. Principles of Disinfection

- Oxidation: Many disinfectants (chlorine,ozone)work by oxidizing cell walls and vital enzymes of microorganisms.
- Radiation damage: UV light damages DNA, preventing microorganisms from reproducing.
- Physical inactivation: Heat or boiling kills pathogens directly.

3. Common Disinfection Methods

1. **Chlorination**
   - Most widely used method.
   - Provides residual protection in pipelines.
   - Forms by-products (tri halo methanes) that must be controlled.
2. **Ozonation**
   - Powerful oxidant, effective against viruses and protozoa.
   - Leaves no residual disinfectant; requires continuous application.
   - Higher cost compared to chlorine.
3. **Ultraviolet (UV) Radiation**
   - Kills microorganisms by damaging DNA.
   - Chemical-free, no taste or odor problems.
   - No residual protection; water may get re-contaminated.
4. **Boiling/Heating**

- Effective household method.
- Impractical for large-scale treatment.

4. Factors Affecting Disinfection Efficiency

- Disinfectant concentration and contact time.
- Turbidity of water (particles shield microbes).
- pH and temperature(affects chemical reaction rates).
- Presence of organic matter (competes with microbes ford is infectant).
- Microorganism type and resistance (protozoan cysts are more resistant).

5. Advantages of Disinfection

- Ensures micro biologically safe water.
- Prevents epidemics of water borne diseases.
- Chlorination provides residual protection.
- Can be adapted for both large-scale plants and household use.

6. Limitations of Disinfection

- Chlorination may form toxic by-products(e.g.,THMs,HAAs).
- Some microbes(e.g.Cryptosporidium) are resistant to chlorine.
- High doses of disinfectants may cause taste and odor issues.
- UV and ozone lack residual effect, so recontamination risk exists.

7. Applications of Disinfection

- Municipal water treatment plants– routine supply of safe drinking water.
- Emergency treatment–chlorine tablets, UV portable systems.
- House hold treatment–boiling, filters with UV lamps.
- Industrial use– ensuring pathogen-free process water.

8. Diagram: Disinfection Process

Filtered Water

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Addition of Disinfectant (Chlorine / Ozone / UV)

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Microorganisms Destroyed

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Safe Drinking Water

9. Conclusion

Disinfection is the last barrier against microbial contamination in drinking water treatment.
By destroying harmful pathogens, it ensures public health safety and compliance with drinking water standards.
Among available methods, chlorination remains dominant due to its cost-effectiveness and residual protection, while advanced methods like UV and ozone are gaining importance in modern treatment plants.