FREQUENTLY ASKED QUESTIONS:

Q no. 1. What do you mean by purified water?

Ans. Purified water is water that has been treated by passing through one or more processes to remove biological and chemical impurities. And contains essentially no dissolved solids (٥,٠ ppm of total dissolved solids).

Q no. 2. What are the different hazards to the water supply

Ans. Water can be contaminated by either chemical impurities or biological impurities. Water being a universal solvent, easily dissolves many chemicals and other materials. Water supplies become contaminated through many different channels. Chemicals can migrate from various disposal sites into the stream of drinking water. Discharges from various industries also pose a threat to safety of water. Water is also prone to contamination by micro-organisms. There are two types of hazards that affect water supply

1) Chemical impurities

Chemicals migrate easily from disposal sites and animal wastes; pesticides may be carried to lakes and streams by rainfall runoff; human wastes may be discharged to receiving water that ultimately flows to water used for drinking. Other sources of contamination include discharge from industry, erosion of natural deposits, corrosion of household plumbing systems, and leaching from septic tanks. Nitrates, inorganic compounds that can enter water supplies from fertilizer runoff and sanitary wastewater discharges, are harmful to young children.

2) Biological impurities

Most outbreaks of water-borne diseases are due to contamination by bacteria and viruses, probably from human or animal waste. Runoff from farms is another source of hazards that affects safety drinking water. Two pathogens commonly associated with drinking water are *Cryptosporidium parvum* and *Giardia lamblia*. Both of these are protozoa whose cysts are difficult to destroy. Contamination with such protozoa causes serious gastrointestinal illness. *Cryptosporidium* in particular may pass through water treatment filtration and disinfection processes in sufficient numbers to cause health problems.

Pathogenic micro – disease-causing organisms that include bacteria, amoebas and viruses, as well as the eggs and larvae of parasitic worms.

Q no. 3. Explain the purpose of pretreatment

Ans. The purpose of pretreatment is to screen large particulates that could hamper subsequent treatment processes. Pretreatments usually involve grit removal by passing water through various mesh screens. Screeners and grit chamber are usually employed in preliminary treatment.

a) **Screeners:**

A screener is a device with openings (usually uniform in size) to remove the floating materials and suspended particles. The process of screening can be carried out by passing sewage through different types of screeners (with different pore sizes). The screeners are classified as coarse, medium or fine, depending on the size of the openings. The coarse screen has larger openings (75-150 mm). The openings for medium and fine screens respectively are 20-50 mm and less than 20 mm. Different types of screens-fixed bar screen (coarse or medium) disc type fine screen, drum type fine screen are in use.

b) **Grit Chambers**

The heavy inorganic materials (specific gravity 2.4-2.7) like sand, ash and others can be removed by using grit chambers. This technique is based on the process of sedimentation due to gravitational forces. Grit chambers may be kept either before or after the screens.

Q no. 4.What is Water Filtration?

Ans. A process in which water passes through a water system that may include one or more filters for the purpose of removing turbidity, taste, color, iron or odor and certain chemicals such as chlorine. The design can be loose media tank-type systems or cartridge devices. In general the process may include mechanical, adsorptive, neutralizing and catalyst/oxidizing filters.

Q no. 5. What do you mean by In-line coagulation?

Ans. In-line coagulation can be used with high-quality source waters (e.g. those where turbidity and other contaminant levels are low). The coagulants are added directly to the raw water pipeline before direct filtration. Typically, the coagulants are added before an in-line static mixer, and it is not necessary to use a basin for sedimentation. In-line coagulation permits the particle destabilization necessary for effective particle removal by filtration, but does not remove microbes by sedimentation.

Q no. 6. Explain Bank-infiltration in detail.

Ans. Bank infiltration refers to the process of surface water seeping from the bank or bed of a river or lake to the production wells of a water treatment plant. During the water's passage through the ground, its quality changes due to microbial, chemical and physical processes, and due to mixing with groundwater. The process can also be described as 'induced infiltration,' because the well-field pumping lowers the water table, causing surface water to flow into the aquifer under a hydraulic gradient. Bank infiltration can be accomplished through natural seepage into receiving ponds, shallow vertical or horizontal wells placed in alluvial sand and gravel deposits adjacent to surface waters, and infiltration galleries. Bank infiltration has been widely used in European countries and is of increased interest in many other countries. Variations on the underground passage concept include soil aquifer treatment, injection of surface water for underground passage and aquifer recharge. The efficiency of the process depends on a number of factors: the quality of the surface water (turbidity, dissolved organic matter, oxygen, ammonia and nutrients), the composition and porosity of the soil, the residence time of the water in the soil and the temperature. This efficiency can vary over time, depending on the difference in level between the source water (e.g. river stage) and groundwater. This difference can influence the degree of groundwater mixing and the residence time of the infiltrated surface water.

Q no. 7. What do you mean by granular high-rate filtration. Explain its mode of action

Ans. Granular media filtration is the most widely used filtration process in drinking water treatment. Under optimal conditions, a combination of coagulation, flocculation, sedimentation and granular media filtration can result in better removal of protozoan pathogens with chlorine-resistant cysts.

Mode of action

Removal of microbial pathogens by granular filtration does not rely on physical processes alone. The removal of particles by granular filtration is considered to involve two steps: transport of particles from suspension to filter medium, followed by attachment of particles to the medium. The transport step depends on the physical and hydrodynamic properties of the system. Transport mechanisms include diffusion, interception and sedimentation. Factors such as size and density of microbes, size and depth of filter medium, and filtration rate affect transport efficiency. In the case of motile microorganisms, an additional mechanism is the active movement of the cell. Attachment is determined by the surface and solution chemistry of the system. Unfavorable interactions between particles and the filter medium must be avoided so that particles can attach to the medium. Chemical coagulation is used before filtration to destabilize particles; this step is the single most important factor in determining filtration efficiency. Without proper chemical pretreatment, rapid rate filtration works as a simple strainer and is not an effective barrier for microbial pathogens.

Q no. 8. What do you mean by roughing filters? Explain with the help of a diagram.

Ans. A roughing filter is a coarse media (typically rock or gravel) filter used to reduce turbidity levels before processes such as slow sand filtration, diatomaceous earth (DE) or membrane filtration. Roughing filters typically have a filter box divided into multiple sections containing gravel beds of decreasing particle size, inlet and outlet structures, and flow-control devices. Roughing filters have peak turbidity removals ranging from 60 to 90%. Generally the more turbid the water is initially, the greater is the reduction that can be achieved. These filters can achieve similar reductions of *coliform*s. Pilot studies of various roughing filter configurations (horizontal-flow, up-flow and down-flow) have shown to reduce reduced faecal coliform bacteria by 93–99.5%. These filters in combination with a dynamic roughing filter (which contains a thin layer of fine gravel on top of a shallow bed of coarse gravel, with a system of under-drains) are used to pretreat high turbidity events, and can achieve a faecal coliform removal of 86.3%. When followed by slow sand filtration, the removal can reach upto 99.8%, with an overall combined treatment efficiency of 4.9–5.5 log units. Roughing filters remove clay particles more effectively than algal cells. Addition of alum coagulant before treatment with a horizontal roughing filter improves the filter's performance for turbidity, color; organic-carbon, head loss, and filter run length.

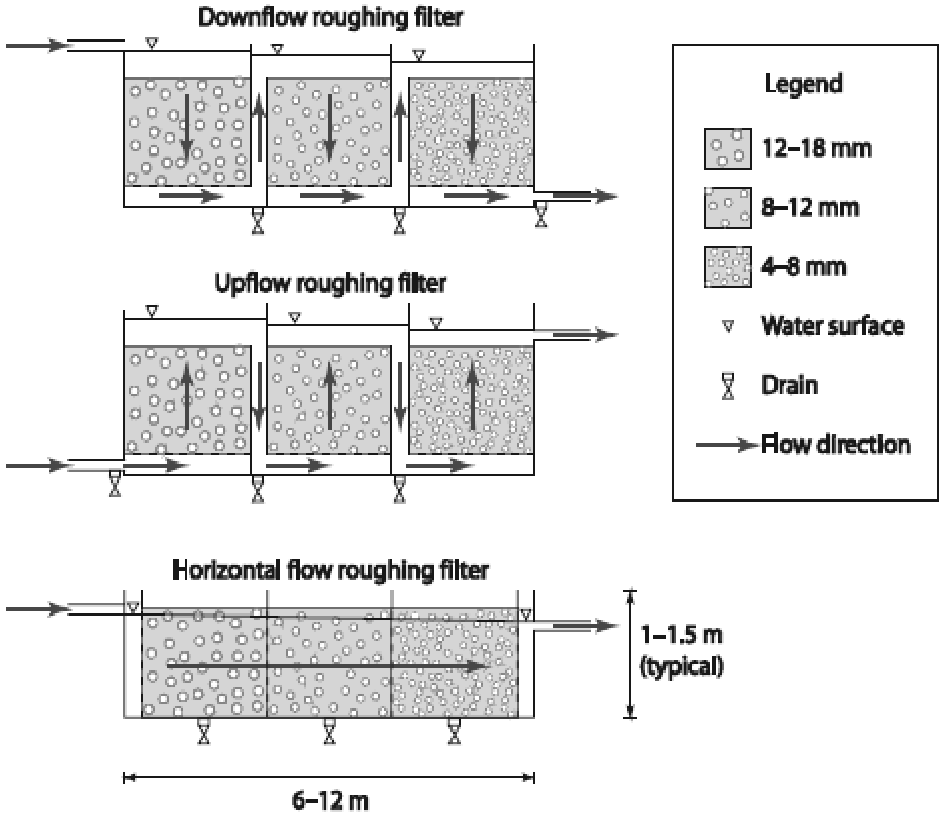


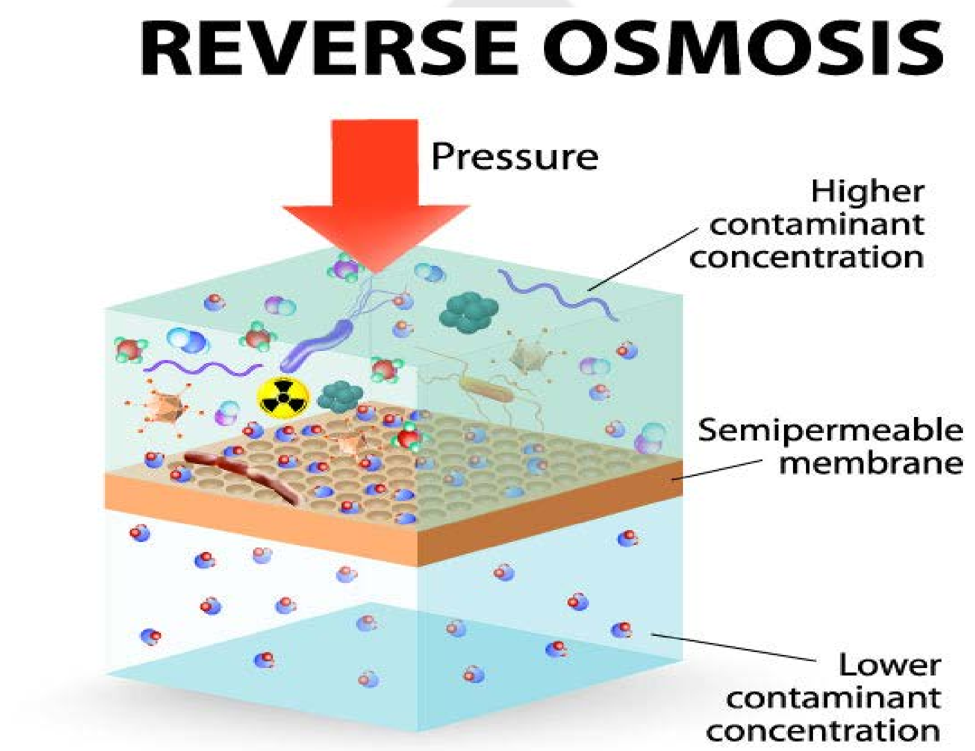
Figure 2.1 Typical roughing filter configurations (Collins et al., 1994)

Q no. 9. What is an ultraviolet (UV) system? How does it work?

Ans. An ultraviolet (UV) system uses UV rays to inactivate certain bacteria, viruses and cysts that may be present in the water source that flows through the systems of UV chamber. The effectiveness of UV depends upon the dose of disinfectant received by the organism i.e., a combination of UV intensity used and the contact time involved.

Q no. 10. What is a reverse osmosis system? Explain with the help of a diagram.

Ans. Reverse osmosis systems produce pure water by forcing untreated water or tap water through a semi permeable membrane. The membrane lets only water molecules pass through directing it to the units storage tank, the impurities that are separated from the water molecules are forced down the drain. The system consists of both pre and post filters which add additional contaminant removal.



Q no. 11. Explain microfiltration and ultrafiltration

Ans. Microfiltration: Microfiltration membranes have pores of 0.1 µm or more. Theoretically, microfiltration can remove protozoa, algae and most bacteria very effectively. However, factors such as bacteria growing in the membrane systems can lead to poor removal of bacteria. Viruses, which are 0.01–0.1 µm in size, can generally pass through microfiltration membranes, but may be removed by the membrane if they are associated with large particles. Numerous pilot studies have directly evaluated the removal of *Giardia*, *Cryptosporidium* and other specific microbial pathogens by microfiltration.

Ultrafiltration: Ultrafiltration membranes have pores of 0.01 µm or more, small enough to remove some viruses in addition to bacteria and protozoa. Ultrafiltration acts as an absolute barrier to protozoan cysts as long as membranes remain intact. It acts as a barrier for *Giardia* and *Cryptosporidium.* Removal of viruses by Ultrafiltration is significantly better than removal by microfiltration, and depends essentially on the pore size of the membranes. The membranes with the lowest molecular weight cutoffs achieve the highest removal efficiency.

Q no. 12. Discuss about lime softening

Ans. Precipitate lime softening is a process in which the pH of the water is increased (usually through the addition of lime or soda ash) to precipitate high concentrations of calcium and magnesium. Typically, calcium can be reduced at pH 9.5–10.5, although magnesium requires pH 10.5–11.5. This distinction is important because the pH of lime softening can inactivate many microbes at the higher end (e.g. pH 10–11), but may have less impact at more moderate levels (e.g. pH 9.5). In precipitate lime softening, the calcium carbonate and magnesium hydroxide precipitates are removed in a clarifier before the water is filtered. The microbial impact of lime softening can, therefore, be a combination of inactivation by elevated pH and removal by settling

Q no. 13. What do you mean by Ion Exchange?

Ans. Ion exchange is a treatment process in which a solid phase presaturant ion is exchanged for an unwanted ion in the untreated water. The process is used for water softening (removal of calcium and magnesium), removal of some radio nuclides (e.g. radium and barium) and removal of various other contaminants (e.g. nitrate, arsenate, chromate, selenate and dissolved organic carbon). The effectiveness of the process depends on the background water quality, and the levels of other competing ions and total dissolved solids. Although some ion exchange systems can be effective for adsorbing viruses and bacteria, such systems are not generally considered a microbial treatment barrier, because the organisms can be released from the resin by competing ions. Also, ion exchange resins may become colonized by bacteria, which can then contaminate treated effluents. Back-flushing and other rinsing procedures, even regeneration, will not remove all of the attached microbes. Impregnation of the resin with silver suppresses bacterial growth initially, but eventually a silver-tolerant population develops.

Q no. 14. What do you mean by bag, cartridge and fibrous filters

Ans. A bag filter is one that has a non-rigid fabric medium for the filter. Water flow is usually pressure-driven from the inside of the filter bag to the outside. A cartridge filter is one that has a rigid fabric medium or membrane for the filter. In this type of filter, water flow is usually pressure-driven from the outside of the filter to the inside. Bag and cartridge filters are often developed for small systems and for point-of-use filtration applications. They are also sometimes applied as a pretreatment process for membrane filtration. Bag filters and cartridge filters remove microorganisms by physical straining. The removal efficiency thus depends primarily on the pore size of the filter medium and on the size of the microbes. A typical pore size range is from 0.2 μm to about 10 μm. The pore size of the filter medium is usually designed to be small enough to remove protozoa such as *Cryptosporidium* and *Giardia*. Submicron particles, including viruses and most bacteria, can pass through the filters. As water passes through a bag or cartridge filter, pressure drop increases to a level impractical for operation. The bag or cartridge is then replaced by a clean one. Since the removal mechanism is physical straining, chemical pretreatment is usually not required for bag filters and cartridge filters. Straining of large compressible particles can blind the filters and reduce filter life. High turbidity and algae can also clog these filters. These processes are therefore only appropriate for high-quality waters. And so, prefiltration process may be employed to remove large particles.

Q no. 15. Explain primary and secondary disinfection

Ans. Primary disinfection: Primary disinfection is typically a chemical oxidation process, although ultraviolet (UV) irradiation and membrane treatment are gaining increased attention. Different types of disinfectant are chlorine, monochlorine, chlorine dioxide, ozone, UV light, and mixed oxidants. These disinfectants are judged in terms of their effectiveness against various pathogenic microorganisms.

1. Chlorination – A water treatment method that destroys harmful bacteria, parasites, and other organisms. Chlorination also removes soluble iron, manganese, and hydrogen sulfide ions from the water.

2. Ozonation – A water treatment process that destroys harmful bacteria and other microorganisms through an infusion of ozone. Ozone (O_3) is a gas created when oxygen molecules are subjected to high electrical voltage.

3. Ultraviolet radiation – A disinfection process for water treatment that involves passing ultraviolet (UV) light through water to kill microorganisms.

Secondary disinfection: The purpose of a secondary disinfectant is to maintain the water quality achieved at the treatment plant throughout the distribution system up to the tap. Secondary disinfection provides a final partial barrier against microbial contamination and serves to control bacterial growth. Monochloramine is a commonly used secondary disinfectant.