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Purification of water

Submitted To :- Submitted By :-

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Certificate

This is to certify that Avani Rege is a student of class XI C has successfully completed the project on the topic “Study of methods of purification of water” under the guidance of Mrs. Shilpi Srivastava during the year 2022-23in partial fulfillment of chemistry practical examination of Central Board of Secondary Education(CBSE).

*Mrs. Shilpi Srivastava*

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***AVANI REGE***

***XI C***

Aim

**To study the methods of purification of water.**

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Introduction

**What is water purification ?**

*Water purification is the process of removing undesirable chemicals, biological contaminants, suspended solids, and gases from water. The goal is to produce water that is fit for specific purposes.*

*The history of water purification includes a wide variety of methods. The methods used include physical processes such as filtration, sedimentation, and distillation; biological processes such as slow sand filters or biologically active carbon; chemical processes such as flocculation and chlorination; and the use of electromagnetic radiation such as ultraviolet light.*

**Importanceof water purification :**

*One major purpose of water purification is to provide clean drinking water. Water purification also meets the needs of medical, pharmacological, chemical, and industrial applications for clean and potable water. The purification procedure reduces the concentration of contaminants such as suspended particles, parasites, bacteria, algae, viruses, and fungi. Water purification takes place on scales from the large (e.g., for an entire city) to the small (e.g., for individual households).*

*The goals of the treatment are to remove unwanted constituents in the water and to make it safe to drink or fit for a specific purpose in industry or medical applications. Widely varied techniques are available to remove contaminants like fine solids, micro-organisms and some dissolved inorganic and organic materials, or environmental persistent pharmaceutical pollutants. The choice of method will depend on the quality of the water being treated, the cost of the treatment process and the quality standards expected of the processed water.*

*Theory*

*The methods of purification of water include physical processes such as*[*filtration*](https://en.m.wikipedia.org/wiki/Filtration)*,*[*sedimentation*](https://en.m.wikipedia.org/wiki/Sedimentation_(water_treatment))*, and*[*distillation*](https://en.m.wikipedia.org/wiki/Distillation)*; biological processes such as*[*slow sand filters*](https://en.m.wikipedia.org/wiki/Slow_sand_filters)*or*[*biologically active carbon*](https://en.m.wikipedia.org/wiki/Activated_carbon)*; chemical processes such as*[*flocculation*](https://en.m.wikipedia.org/wiki/Flocculation)*and*[*chlorination*](https://en.m.wikipedia.org/wiki/Water_chlorination)*; and the use of electromagnetic radiation such as*[*ultraviolet light*](https://en.m.wikipedia.org/wiki/Ultraviolet_germicidal_irradiation)*.*

*The processes below are the ones commonly used in water purification plants. Some or most may not be used depending on the scale of the plant and quality of the raw (source) water.*

1. **Pretreatment**

* Pumping and containment – The majority of water must be pumped from its source or directed into pipes or holding tanks. To avoid adding contaminants to the water, this physical infrastructure must be made from appropriate materials and constructed so that accidental contamination does not occur.
* Screening (see also screen filter) – The first step in purifying surface water is to remove large debris such as sticks, leaves, rubbish and other large particles which may interfere with subsequent purification steps. Most deep groundwater does not need screening before other purification steps.
* Storage – Water from rivers may also be stored in bankside reservoirs for periods between a few days and many months to allow natural biological purification to take place. This is especially important if treatment is by slow sand filters. Storage reservoirs also provide a buffer against short periods of drought or to allow water supply to be maintained during transitory pollution incidents in the source river.
* Pre-chlorination – In many plants the incoming water was chlorinated to minimize the growth of fouling organisms on the pipe-work and tanks. Because of the potential adverse quality effects (see chlorine below), this has largely been discontinued.

1. **PH Adjustment**

Pure water has a pH close to 7 (neither alkaline nor acidic). Sea water can have pH values that range from 7.5 to 8.4 (moderately alkaline). Fresh water can have widely ranging pH values depending on the geology of the drainage basin or aquifer and the influence of contaminant inputs (acid rain). If the water is acidic (lower than 7), lime, soda ash, or sodium hydroxide can be added to raise the pH during water purification processes. Lime addition increases the calcium ion concentration, thus raising the water hardness. For highly acidic waters, forced draft degasifiers can be an effective way to raise the pH, by stripping dissolved carbon dioxide from the water. Making the water alkaline helps coagulation and flocculation processes work effectively and also helps to minimize the risk of lead being dissolved from lead pipes and from lead solder in pipe fittings. Sufficient alkalinity also reduces the corrosiveness of water to iron pipes. Acid (carbonic acid, hydrochloric acid or sulfuric acid) may be added to alkaline waters in some circumstances to lower the pH. Alkaline water (above pH 7.0) does not necessarily mean that lead or copper from the plumbing system will not be dissolved into the water. The ability of water to precipitate calcium carbonate to protect metal surfaces and reduce the likelihood of toxic metals being dissolved in water is a function of pH, mineral content, temperature, alkalinity and calcium concentration.

1. **Coagulation and flocculation**

In water treatment, coagulation and flocculation involve the addition of compounds that promote the clumping of fine floc into larger floc so that they can be more easily separated from the water. Coagulation is a chemical process that involves neutralization of charge whereas flocculation is a physical process and does not involve neutralization of charge. The coagulation-flocculation process can be used as a preliminary or intermediary step between other water or wastewater treatment processes like filtration and sedimentation. Iron and aluminium salts are the most widely used coagulants but salts of other metals such as titanium and zirconium have been found to be highly effective as well.

1. **Sedimentation**

This process using gravity to remove suspended solids from water. Solid particles entrained by the turbulence of moving water may be removed naturally by sedimentation in the still water of lakes and oceans. Settling basins are ponds constructed for the purpose of removing entrained solids by sedimentation. Clarifiers are tanks built with mechanical means for continuous removal of solids being deposited by sedimentation .Clarification does not remove dissolved species. Sedimentation is the act of depositing sediment.

1. **Dissolved air flotation**

When particles to be removed do not settle out of solution easily, dissolved air flotation (DAF) is often used. After coagulation and flocculation processes, water flows to DAF tanks where air diffusers on the tank bottom create fine bubbles that attach to the floc resulting in a floating mass of concentrated floc. The floating floc blanket is removed from the surface and clarified water is withdrawn from the bottom of the DAF tank. Water supplies that are particularly vulnerable to unicellular algae blooms and supplies with low turbidity and high colour often employ DAF.

1. **Filtration**

After separating most floc, the water is filtered as the final step to remove remaining suspended particles and unsettled floc.

**Rapid sand filters**

The most common type of filter is a rapid sand filter. Water moves vertically through sand which often has a layer of activated carbon or anthracite coal above the sand. The top layer removes organic compounds, which contribute to taste and odour. The space between sand particles is larger than the smallest suspended particles, so simple filtration is not enough. Most particles pass through surface layers but are trapped in pore spaces or adhere to sand particles. Effective filtration extends into the depth of the filter. This property of the filter is key to its operation: if the top layer of sand were to block all the particles, the filter would quickly clog.

To clean the filter, water is passed quickly upward through the filter, opposite the normal direction (called *backflushing* or [*backwashing*](https://en.m.wikipedia.org/wiki/Backwashing_(water_treatment))) to remove embedded or unwanted particles. Prior to this step, compressed air may be blown up through the bottom of the filter to break up the compacted filter media to aid the backwashing process; this is known as *air scouring*. This contaminated water can be disposed of, along with the sludge from the sedimentation basin, or it can be recycled by mixing with the raw water entering the plant although this is often considered poor practice since it re-introduces an elevated concentration of bacteria into the raw water.

**Slow sand filters**

[Slow sand filters](https://en.m.wikipedia.org/wiki/Slow_sand_filter) may be used where there is sufficient land and space, as the water flows very slowly through the filters. These filters rely on biological treatment processes for their action rather than physical filtration. They are carefully constructed using graded layers of sand, with the coarsest sand, along with some gravel, at the bottom and the finest sand at the top. Drains at the base convey treated water away for disinfection. Filtration depends on the development of a thin biological layer, called the zoogleal layer or [Schmutzdecke](https://en.m.wikipedia.org/wiki/Schmutzdecke), on the surface of the filter. An effective slow sand filter may remain in service for many weeks or even months, if the pretreatment is well designed, and produces water with a very low available nutrient level which physical methods of treatment rarely achieve. Very low nutrient levels allow water to be safely sent through distribution systems with very low disinfectant levels, thereby reducing consumer irritation over offensive levels of chlorine and chlorine by-products. Slow sand filters are not backwashed; they are maintained by having the top layer of sand scraped off when the flow is eventually obstructed by biological growth.

**Bank filtration**

In bank filtration, natural sediments in a riverbank are used to provide the first stage of contaminant filtration. While typically not clean enough to be used directly for drinking water, the water gained from the associated extraction wells is much less problematic than river water taken directly from the river.

1. **Disinfection**

Disinfection is accomplished both by filtering out harmful micro-organisms and by adding disinfectant chemicals. Water is disinfected to kill any pathogens which pass through the filters and to provide a residual dose of disinfectant to kill or inactivate potentially harmful micro-organisms in the storage and distribution systems. Possible pathogens include viruses, bacteria, including Salmonella, Cholera, Campylobacter and Shigella, and protozoa, including Giardia lamblia and other cryptosporidia. After the introduction of any chemical disinfecting agent, the water is usually held in temporary storage – often called a contact tank or clear well – to allow the disinfecting actiocryptosporidia

**Chlorine disinfection**

The most common disinfection method involves some form of chlorine or its compounds such as chloramine or chlorine dioxide. Chlorine is a strong oxidant that rapidly kills many harmful micro-organisms. Because chlorine is a toxic gas, there is a danger of a release associated with its use. This problem is avoided by the use of sodium hypochlorite, which is a relatively inexpensive solution used in household bleach that releases free chlorine when dissolved in water. Chlorine solutions can be generated on site by electrolyzing common salt solutions. A solid form, calcium hypochlorite, releases chlorine on contact with water. Handling the solid, however, requires more routine human contact through opening bags and pouring than the use of gas cylinders or bleach, which are more easily automated. The generation of liquid sodium hypochlorite is inexpensive and also safer than the use of gas or solid chlorine. Chlorine levels up to 4 milligrams per litre (4 parts per million) are considered safe in drinking water.

**Chlorine dioxide disinfection**

Chlorine dioxide is a faster-acting disinfectant than elemental chlorine. It is relatively rarely used because in some circumstances it may create excessive amounts of chlorite, which is a by-product regulated to low allowable levels in the United States. Chlorine dioxide can be supplied as an aqueous solution and added to water to avoid gas handling problems; chlorine dioxide gas accumulations may spontaneously detonate.

**Chloramination**

The use of chloramine is becoming more common as a disinfectant. Although chloramine is not as strong an oxidant, it provides a longer-lasting residual than free chlorine because of its lower redox potential compared to free chlorine. It also does not readily form THMs or haloacetic acids (disinfection byproducts).

It is possible to convert chlorine to chloramine by adding ammonia to the water after adding chlorine. The chlorine and ammonia react to form chloramine. Water distribution systems disinfected with chloramines may experience nitrification, as ammonia is a nutrient for bacterial growth, with nitrates being generated as a by-product.

**Ozone disinfection**

Ozone is an unstable molecule which readily gives up one atom of oxygen providing a powerful oxidizing agent which is toxic to most waterborne organisms. It is a very strong, broad spectrum disinfectant that is widely used in Europe and in a few municipalities in the United States and Canada. Ozone disinfection, or ozonation, is an effective method to inactivate harmful protozoa that form cysts. It also works well against almost all other pathogens. Ozone is made by passing oxygen through ultraviolet light or a “cold” electrical discharge. To use ozone as a disinfectant, it must be created on-site and added to the water by bubble contact. Some of the advantages of ozone include the production of fewer dangerous by-products and the absence of taste and odour problems (in comparison to chlorination). No residual ozone is left in the water.[13] In the absence of a residual disinfectant in the water, chlorine or chloramine may be added throughout a distribution system to remove any potential pathogens in the distribution piping.

**Ultraviolet disinfection**

Ultraviolet light (UV) is very effective at inactivating cysts, in low turbidity water. UV light’s disinfection effectiveness decreases as turbidity increases, a result of the absorption, scattering, and shadowing caused by the suspended solids. The main disadvantage to the use of UV radiation is that, like ozone treatment, it leaves no residual disinfectant in the water; therefore, it is sometimes necessary to add a residual disinfectant after the primary disinfection process. This is often done through the addition of chloramines, discussed above as a primary disinfectant. When used in this manner, chloramines provide an effective residual disinfectant with very few of the negative effects of chlorination.

**Other water purification techniques :**

Other popular methods for purifying water, especially for local private supplies are listed below. In some countries some of these methods are used for large scale municipal supplies. Particularly important are distillation (desalination of seawater) and reverse osmosis.

**Thermal**

Bringing water to its boiling point (about 100 °C or 212 F at sea level), is the oldest and most effective way since it eliminates most microbes causing intestinal disease, but it cannot remove chemical toxins or impurities. For human health, complete sterilization of water is not required, since heat resistant microbes do not affect intestines.The traditional advice of boiling water for ten minutes is mainly for additional safety, since microbes start expiring at temperatures greater than 60 °C (140 °F). Though the boiling point decreases with increasing altitude, it is not enough to affect disinfection. In areas where the water is “hard” (that is, containing significant dissolved calcium salts), boiling decomposes the bicarbonate ions, resulting in partial precipitation as calcium carbonate. This is the “fur” that builds up on kettle elements, etc., in hard water areas. With the exception of calcium, boiling does not remove solutes of higher boiling point than water and in fact increases their concentration (due to some water being lost as vapour). Boiling does not leave a residual disinfectant in the water. Therefore, water that is boiled and then stored for any length of time may acquire new pathogens.

**Adsorption**

Granular activated carbon is a form of [activated carbon](https://en.m.wikipedia.org/wiki/Activated_carbon) with a high surface area. It adsorbs many compounds including many toxic compounds. Water passing through [activated carbon](https://en.m.wikipedia.org/wiki/Activated_carbon) is commonly used in municipal regions with organic contamination, taste or odours. Many household water filters and fish tanks use activated carbon filters to purify water. Household filters for drinking water sometimes contain [silver](https://en.m.wikipedia.org/wiki/Silver) as metallic [silver nanoparticle](https://en.m.wikipedia.org/wiki/Silver_nanoparticle). If water is held in the carbon block for longer periods, microorganisms can grow inside which results in fouling and contamination. Silver nanoparticles are excellent anti-bacterial material and can decompose toxic halo-organic compounds such as pesticides into non-toxic organic products.[[24]](https://en.m.wikipedia.org/wiki/Water_purification#cite_note-24) Filtered water must be used soon after it is filtered, as the low amount of remaining microbes may proliferate over time. In general, these home filters remove over 90% of the chlorine in a glass of treated water. These filters must be periodically replaced otherwise the bacterial content of the water may actually increase due to the growth of bacteria within the filter unit.

**Distillation**

[Distillation](https://en.m.wikipedia.org/wiki/Distillation) involves boiling water to produce water [vapour](https://en.m.wikipedia.org/wiki/Vapour). The vapour contacts a cool surface where it condenses as a liquid. Because the solutes are not normally vaporised, they remain in the boiling solution. Even distillation does not completely purify water, because of contaminants with similar boiling points and droplets of unvapourised liquid carried with the steam. However, 99.9% pure water can be obtained by distillation.

Direct contact membrane distillation (DCMD) passes heated seawater along the surface of a [hydrophobic](https://en.m.wikipedia.org/wiki/Hydrophobic) [polymer](https://en.m.wikipedia.org/wiki/Polymer) membrane. Evaporated water passes from the hot side through pores in the membrane forming a stream of cold pure water on the other side. The difference in vapour pressure between the hot and cold side helps to push water molecules through.

**Reverse Osmosis**

[Reverse osmosis](https://en.m.wikipedia.org/wiki/Reverse_osmosis) involves mechanical pressure applied to force water through a [semi-permeable membrane](https://en.m.wikipedia.org/wiki/Semi-permeable_membrane). Contaminants are left on the other side of the membrane. Reverse osmosis is theoretically the most thorough method of large scale water purification available, although perfect semi-permeable membranes are difficult to create. Unless membranes are well-maintained, [algae](https://en.m.wikipedia.org/wiki/Algae) and other life forms can colonize the membranes.

**Crystallization**

Carbon dioxide or other low molecular weight gas can be mixed with contaminated water at high pressure and low temperature to exothermically form gas hydrate crystals. Hydrate may be separated by centrifuge or sedimentation. Water can be released from the hydrate crystals by heating.

**Water Conditioning**

This is a method of reducing the effects of hard water. In water systems subject to heating hardness salts can be deposited as the decomposition of bicarbonate ions creates carbonate ions that precipitate out of solution. Water with high concentrations of hardness salts can be treated with soda ash (sodium carbonate) which precipitates out the excess salts, through the [common-ion effect](https://en.m.wikipedia.org/wiki/Common-ion_effect), producing calcium carbonate of very high purity. The precipitated calcium carbonate is traditionally sold to the manufacturers of [toothpaste](https://en.m.wikipedia.org/wiki/Toothpaste). Several other methods of industrial and residential water treatment are claimed (without general scientific acceptance) to include the use of magnetic and/or electrical fields reducing the effects of hard water.

**Plumbosolvency Reduction**

In areas with naturally acidic waters of low conductivity (i.e. surface rainfall in upland mountains of igneous rocks), the water may be capable of dissolving lead from any lead pipes that it is carried in. The addition of small quantities of phosphate ion and increasing the pH slightly both assist in greatly reducing plumbo-solvency by

creating insoluble lead salts on the inner surfaces of the pipes.

Conclusion

Water plays such an important role in our daily lives. 70% of our body is composed of water. 70% of the earth surface is also made up of water, but out of the 70%, only 1/3 of water is consumable. In fact, this amount has been continuously to decrease as more and more industries began to pollute and damage the [water](https://www.123helpme.com/topics/water). For example, many toxic chemicals may be released into the water thus making the water impure. Such pollutions and damages lead the water to be contaminated and inconsumable as it may cause severe diseases. Water purification can remove all the unnecessary bacteria and viruses from the water that is hazardous for our health. Water purification may also improve the flavour and appearance of water. It removes the unpleasant odour.

Therefore, water purification became one of the most useful and popular process used by people all over the world today. It is by far the most recommended and safest water treatment that is commonly used to purify damaged water into consumable water. Water purification provides us with safe, pure and clean water to consume and use.

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***Thank You !***