Purification of Water

A Research Work Submitted for the partial fulfilment of requirement in Chemistry of Class 11

Submitted to
Moonlight Secondary School
Kumaripati, Lalitpur
Lalitpur, Nepal
2078/12/05

Submitted By
Deepa Das
Roll No: 26

CERTIFICATE OF APPROVAL

This is to certify that the project work entitled **Purification of Water** in the partial fulfilment of the requirement of chemistry class 11 **SDB** is submitted by **Deepa Das** under the supervision of **Pusp Bhat** has been accepted.

Supervisor:
Name: **Pusp Bhatta**
Department of Chemistry
Name of School/ College: Moonlight Secondary School

Head of the Department:
Name: **Rajib Chaudhary**
Department of Chemistry
Name of School/ College: Moonlight Secondary School

LETTER OF RECOMMENDATION

This is to recommend **Mr. Deepa Das** of Moonlight Secondary School has done the project work entitled Purification of Water for the partial fulfillment of the requirement for Chemistry class 11. To the best of my knowledge, this work has not been previously formed for any other degree. She has fulfilled all the requirements laid down by NEB for the submission of project work for the award of +2 degree.

Signature : —-------------
Name of Supervisor: Pusp Bhat
Designation of Supervisor
Date: 2078/12/29

DECLARATION

The project work entitled **Purification of Water**, which is being submitted to the Department of Chemistry, **Moonlight Secondary School,** Nepal for the award of Class 11 degree in Chemistry, is carried out by **Mr. Deepa Das** under the supervision of **Pusp Bhat**, Department of Chemistry, **Moonlight Secondary School**. I hereby, declare that this work is originally done by me and has not been previously formed anywhere else for another degree. Any literature, data or work done by others or cited in this project work has been given due acknowledgement and listed in the reference section.

Signature
Name of Student: Deepa Das
Date: 2078/12/29
Email: dd3317875@gmail.com

ACKNOWLEDGEMENTS

I feel immense pleasure in acknowledging my ineptness and heartfelt sense of gratitude to my respected supervisor **Pusp Bhat**, Department of Chemistry, **Moonlight Secondary School** for his/her sustained encouragement, regular guidance, inspiration, valuable suggestion and great support throughout my period.

My special thanks go to the Head of Department, **Rajib Chaudhary, Moonlight Secondary School** for providing us necessary requirements and suggestions.

I would like to thank and express my sincere appreciation to all the friends, family and teachers for great support.

Thank you all
Name of student: **Deepa Das**
Date: **2078/12/29**

Water purification, process by which undesired chemical compounds, organic and inorganic materials, and biological contaminants are removed from water. That process also includes distillation (the conversion of a liquid into vapour to condense it back to liquid form) and deionization (ion removal through the extraction of dissolved salts). 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).

Most communities rely on natural bodies of water as intake sources for water purification and for day-to-day use. In general, these resources can be classified as groundwater or surface water and commonly include underground aquifers, creeks, streams, rivers, and lakes. With recent technological advancements, oceans and saltwater seas have also been used as alternative water sources for drinking and domestic use.

Determining the water quality

Historical evidence suggests that water treatment was recognized and practised by ancient civilizations. Basic treatments for water purification have been documented in Greek and Sanskrit writings, and Egyptians used alum for precipitation as early as 1500 BCE.

In modern times, the quality to which water must be purified is typically set by government agencies. Whether set locally, nationally, or internationally, government standards typically set maximum concentrations of harmful contaminants that can be allowed in safe water. Since it is nearly impossible to examine water simply on the basis of appearance, multiple processes, such as physical, chemical, or biological analyses, have been developed to test contamination levels. Levels of organic and inorganic chemicals, such as chloride, copper, manganese, sulphates, and zinc, microbial pathogens, radioactive materials, and dissolved and suspended solids, as well as pH, odour, colour, and taste, are some of the common parameters analysed to assess water quality and contamination levels.

Regular household methods such as boiling water or using an activated-carbon filter can remove some water contaminants. Although those methods are popular because they can be used widely and inexpensively, they often do not remove more dangerous contaminants. For example, natural spring water from artesian wells was historically considered clean for all practical purposes, but it came under scrutiny during the first decade of the 21st century because of worries over pesticides, fertilisers, and other chemicals from the surface entering wells. As a result, artesian wells were subjected to treatment and batteries of tests, including tests for the parasite ***Cryptosporidium***.

Not all people have access to safe drinking water. According to a 2017 report by the United Nations (UN) World Health Organization (WHO), 2.1 billion people lack access to a safe and reliable drinking water supply at home. Eighty-eight percent of the four billion annual cases of diarrhoea reported worldwide have been attributed to a lack of sanitary drinking water. Each year approximately 525,000 children under age five die from diarrhoea, the second leading cause of death, and 1.7 million are sickened by diarrheal diseases caused by unsafe water, coupled with inadequate sanitation and hygiene.

Water Filters

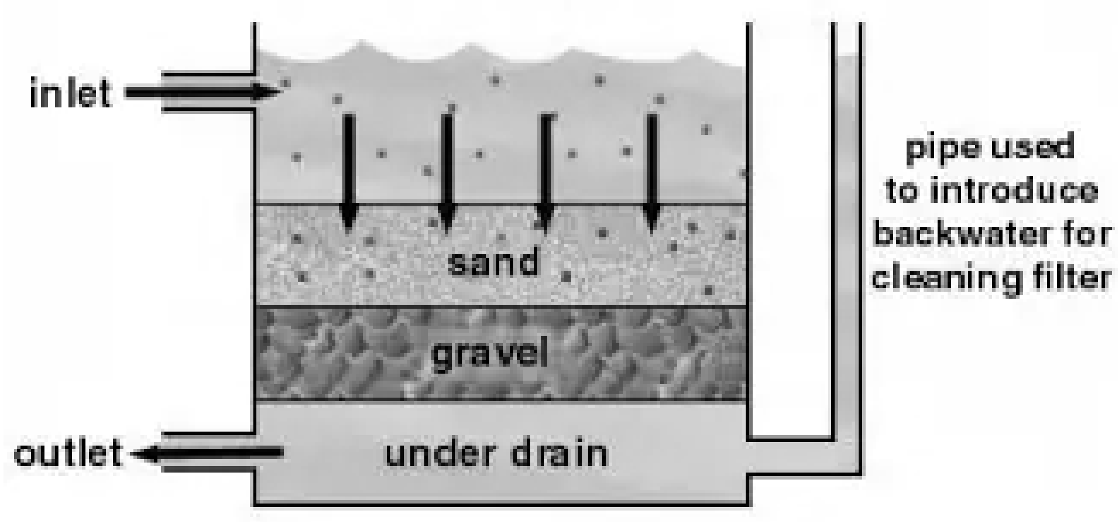


Figure: Filtration of Water

Water filtration is the process of removing or reducing the concentration of particulate matter, including suspended particles, parasites, bacteria, algae, viruses, and fungi, as well as other undesirable chemical and biological contaminants from contaminated water to produce safe and clean water for a specific purpose, such as drinking, medical, and pharmaceutical applications.

Once the flocs have settled to the bottom of the water, the clear water on top is filtered to separate additional solids from the water. During filtration, the clear water passes through filters that have different pore sizes and are made of different materials (such as sand, gravel, and charcoal). These filters remove dissolved particles and germs, such as dust, chemicals, parasites, bacteria, and viruses. Activated carbon filters also remove any bad odours.

Water treatment plants can use a process called ultrafiltration in addition to or instead of traditional filtration. During ultrafiltration, the water goes through a filter membrane with very small pores. This filter only lets through water and other small molecules (such as salts and tiny, charged molecules).

Sedimentation

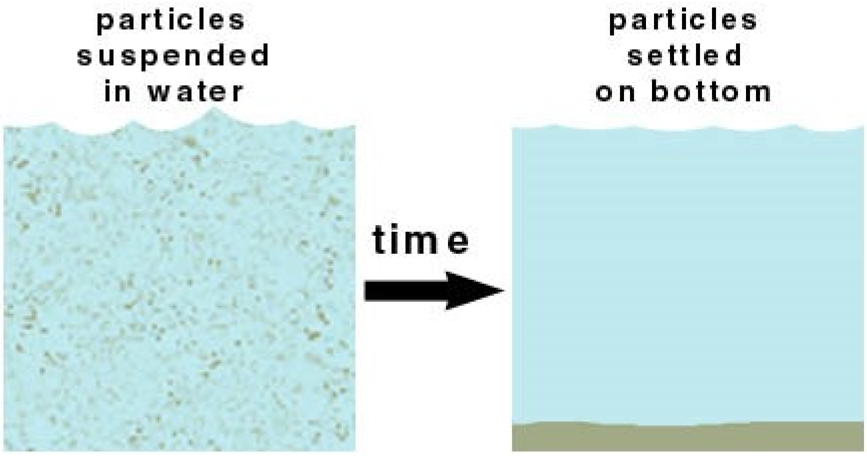
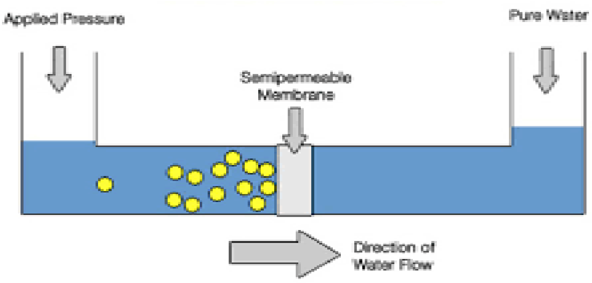


Figure: Sedimentation

Waters exiting the flocculation basin may enter the sedimentation basin, also called a clarifier or settling basin. It is a large tank with low water velocities, allowing floc to settle to the bottom. The sedimentation basin is best located close to the flocculation basin so the transit between the two processes does not permit settlement or floc break up. Sedimentation basins may be rectangular, where water flows from end to end, or circular where flow is from the centre outward. Sedimentation basin outflow is typically over a weir so only a thin top layer of water—that furthest from the sludge—exits.

In 1904, Allen Hazen showed that the efficiency of a sedimentation process was a function of the particle settling velocity, the flow through the tank and the surface area of tank. Sedimentation tanks are typically designed within a range of overflow rates of 0.5 to 1.0 gallons per minute per square foot (or 1.25 to 2.5 litres per square metre per hour). In general, sedimentation basin efficiency is not a function of detention time or depth of the basin. Although, basin depth must be sufficient so that water currents do not disturb the sludge and settled particle interactions are promoted. As particle concentrations in the settled water increase near the sludge surface on the bottom of the tank, settling velocities can increase due to collisions and agglomeration of particles. Typical detention times for sedimentation vary from 1.5 to 4 hours and basin depths vary from 10 to 15 feet (3 to 4.5 metres).

Reverse Osmosis



Reverse osmosis (RO) is a water purification process that uses a partially permeable membrane to separate ions, unwanted molecules and larger particles from drinking water. In reverse osmosis, an applied pressure is used to overcome osmotic pressure, a colligative property that is driven by chemical potential differences of the solvent, a thermodynamic parameter. Reverse osmosis can remove many types of dissolved and suspended chemical species as well as biological ones (principally bacteria) from water, and is used in both industrial processes and the production of potable water. The result is that the solute is retained on the pressurised side of the membrane and the pure solvent is allowed to pass to the other side. To be "selective", this membrane should not allow large molecules or ions through the pores (holes), but should allow smaller components of the solution (such as solvent molecules, e.g., water, H_2O) to pass freely.

Solar water Disinfection

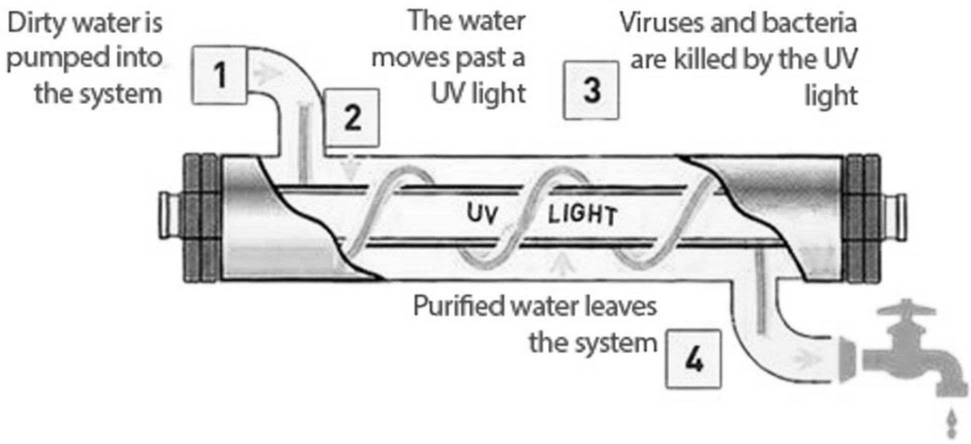


Figure: UV-ray Treatment of Water

Solar water disinfection, in short SODIS, is a type of portable water purification that uses solar energy to make biologically-contaminated (e.g. bacteria, viruses, protozoa and worms) water safe to drink. Water contaminated with non-biological agents such as toxic chemicals or heavy metals require additional steps to make the water safe to drink.

Solar water disinfection is usually accomplished using some mix of electricity generated by photovoltaic panels (solar PV), heat (solar thermal), and solar ultraviolet light collection.

Solar disinfection using the effects of electricity generated by photovoltaics typically uses an electric current to deliver electrolytic processes which disinfect water, for example by generating oxidative free radicals which kill pathogens by damaging their chemical structure. A second approach uses stored solar electricity from a battery, and operates at night or at low light levels to power an ultraviolet lamp to perform secondary solar ultraviolet water disinfection.

Distillation

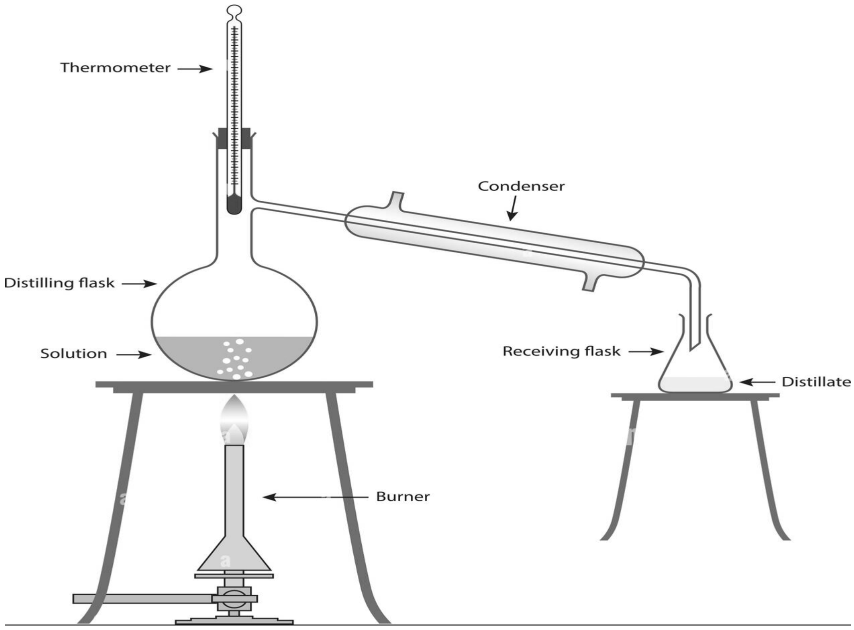


Figure: Distillation of Water

Distillation is one of the oldest methods of water treatment and is still in use today, though not commonly as a home treatment method. It can effectively remove many contaminants from drinking water, including bacteria, inorganic and many organic compounds. It is a process that relies on evaporation to purify water. Contaminated water is heated to form steam. Inorganic compounds and large non-volatile organic molecules do not evaporate with the water and are left behind. The steam then cools and condenses to form purified water.

Distillation effectively removes inorganic compounds such as metals (lead), nitrate, and other nuisance particles such as iron and hardness from a contaminated water supply.

Distillation's effectiveness in removing organic compounds varies, depending on such chemical characteristics of the organic compound as solubility and boiling point. Organic compounds with boiling points lower than the boiling point of water (ex. benzene and toluene) vaporise along with the water.

Ultraviolet disinfection

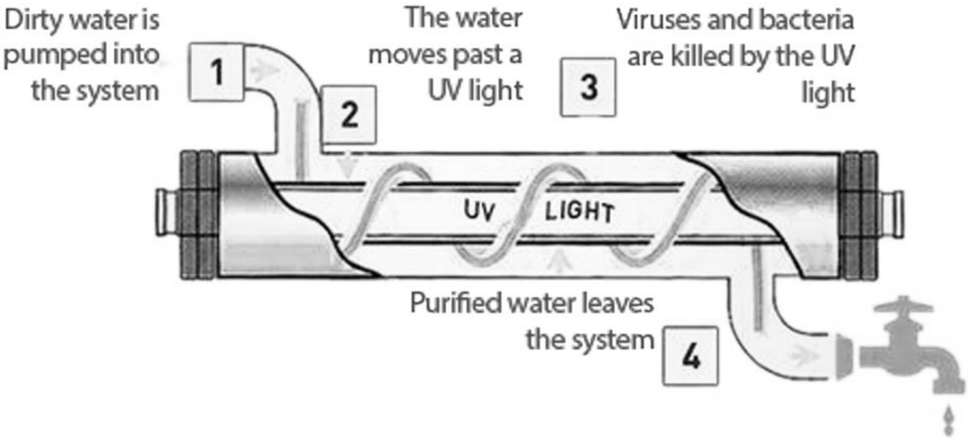


Figure: UV-ray Treatment of Water

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.

Over 2 million people in 28 developing countries use Solar Disinfection for daily drinking water treatment.

Ozone disinfection

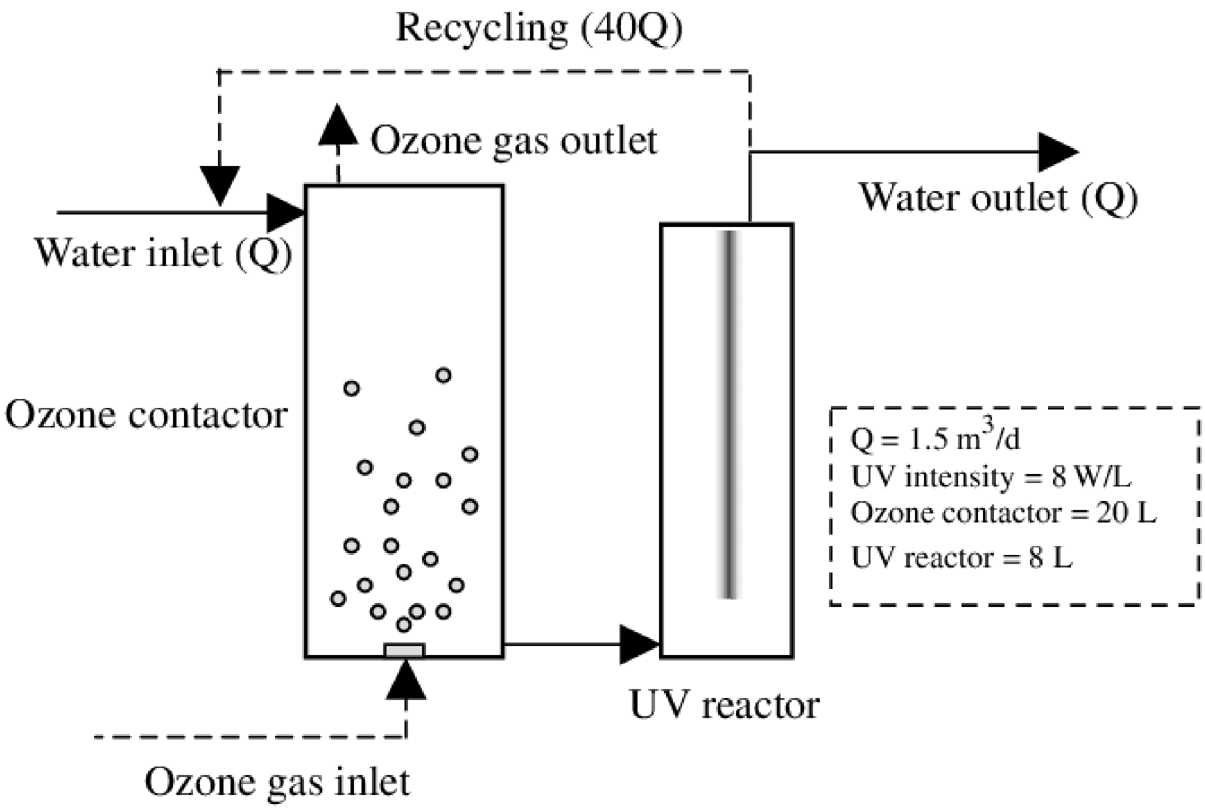


Figure : Ozone Disinfection

Ozone is an unstable molecule which readily gives up one atom of oxygen providing a powerful oxidising 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. 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.

Boiling

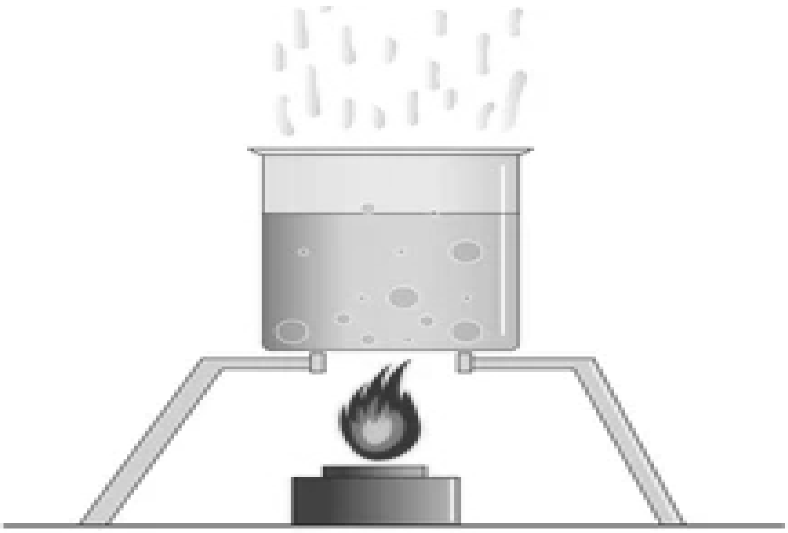


Figure: Boiling Water

The simplest method to purify water is to boil it for a good amount of time. High temperatures cause the bacteria and virus to dissipate, removing all impurities from the water. In doing so, chemical additions cease to exist in the water as well. However, the dead micro-organisms and impurities settle at the bottom of the water, and boiling does not help eliminate all the impurities. You must strain the water through a microporous sieve to completely get rid of the impurities.