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USING RAW GROUND WATER FOR THE DEVELOPMENT OF ORGANIC MINERAL WATER

Zaib-un-Nisa
Abdullah Yasar
Ahmad Ibrahim
Iqra Wasif

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By

Zaib-un-Nisa[1], Abdullah Yasar[1], Ahmad Ibrahim[1], Iqra Wasif[1]

Abstract

Drinking water quality and safety for the people is always an issue in the regions in which water quality is not appropriate. Total dissolved solids (TDS) is a significant characteristic affecting the quality and health, causing quality of water monitoring necessary for ensuring safe drinking water. Problems linked to the high TDS level (more than 500-2000 mg/ L) includes gastrointestinal and cardiovascular diseases. Considering a particular focus on the membrane filtration approaches, like micro filtration (MF), Ultrafiltration (UF), Nano filtration (NF) and reverse osmosis (RO) for decrease in TDS, this review evaluates innovative water treatment methods. RO is an effective technique for removing bacteria, dissolved solids, dissolved solids and other contaminants although its efficiency is constrained by membrane fouling and operational inefficiency.

Furthermore, due to its strong oxidative and disinfecting characteristics, ozonation has grown into an effective water treatment technology. Ozone rapidly removes the E.coli and viruses while producing harmful disinfectant waste products in contrast with chlorine. The use of ozonation in drinking water treatment, its capacity to kill bacteria resistant to chlorine, and its efficiency in breaking the organic micropollutants (OMPs) are discussed in this review. By generating extremely reactive hydroxyl radicals, advanced oxidation processes (AOP) increase water treatment even more.

The research significance to enhance the efficiency of treatment, reducing operational cost and provide sustainable alternative for conventional alternative which produces harmful disinfection byproducts make the research essential. Ozonation is a powerful oxidation technique which is emphasized of its unique disinfection qualities and capacity to remove OMPs and bacteria resistance to chlorine.

In accordance to the study combines the RO with ozonation significantly increase the quality of water, ensuring safe drinking water and dealing with environmental issues. It is important to resolve problems like membrane fouling, high electrical consumption, and financial constraints. further

[1] Sustainable Development Study Centre (SDSC), Governmental College University, Lahore, 54000, Pakistan. Corresponding Author: yasar.abdullah@gcu.edu.pk

research must develop energy efficient membranes, improve treatment parameters and for commercial application scale up ozonation. Combining the RO filtration and oxidation method will increase the water sustainability and security.

Introduction

Freshwater resources are in danger due to glaciers first melting which has been triggered by climate change. Approximately 70% freshwater is stored in glaciers that are melting away at rates that were previously unheard of. For many people who rely on meltwater from glaciers for drinking, cultivation and producing electricity, this decline puts their drinking water supply in danger (Sing et al., 2021). Several regions are using marginal groundwater that can be brackish or polluted as an alternative for drinking water as glacier sources become less plentiful (Saha et al., 2022).

The main sources of drinking water are water bodies, river bed, aquifer fluids and dams. Since the supplies of groundwater associated to the solid rock geology are limited and restricted, surface level water including river and reservoirs supply the most of the flow (Mishra et al., 2023) When the supply of water is unsuccessful it can be termed as an issue with the quality of water.

At four various points the water problem occurs in the supply chain, the source, process of treatment, during water transportation to the customer home and home piping system (Savic et al., 2024). The less expensive the end product, the purer the raw water to drink and the simpler it is to produce (Zhang et al., 2021).

Natural and human activities are the main source of increase the TDS level in water. (Manoj et al., 2024). If the level of TDS in drinking water is more than 500 to 2000mg/L so it causes harmful impact on human health (Pushpalatha et al., 2022). Water which contains the high TDS level is unacceptable to drink because of its taste which could be salty and bitter. RO is used to remove the various contaminants from water and ozonation is used to disinfect and degrade the organic pollutants.

Membrane filtration is a process which physically separates the pollutants in drinking water and produces a permeate of pure water. Membrane filtration contains a selectively permeable membrane which allows only specific particles to pass and captures the other (Zhang et al., 2021). It also contains the process of polarization because the movement through membranes is in the form of ions (Park et al., 2020). On the basis of pressure gradient across membrane. There are different types of membranes such as; micro-filtration (MF), Ultra-filtration (UF), Nano-

filtration (NF) and reverse Osmosis (RO) (Saha et al., 2022). They are used to treat the waste water as well as drinking water and desalination of seawater and surface water. The only difference between them is the pore size of the membrane and the type of contaminant they remove. The result is the water and waste water movement through membranes and separation of various cations and anions which pass through the pores of membrane (Ahmed et al., 2022).

Micro-Filtration

Microfiltration process is generally used to remove microorganisms, viruses, suspended solids, organic matter and metals from water (Nandakumar et al., 2025). This is basically a pressure driven process which physically separates the dissolved solids from water. The pore size of membrane ranges from 0.1 to 10 µm and when water passes through these membranes the dissolved solids retain and water passes through causing the filtration of water (Cevallos-Mendoza et al., 2022). These membranes are primarily used for the removal of Total Dissolved Solids (TDS), bacteria, viruses and other contaminants and thus reduces turbidity by 95 to 97%. The pore size of microfiltration membranes is relatively large so they can be operated at low pressure (Osman et al., 2021).

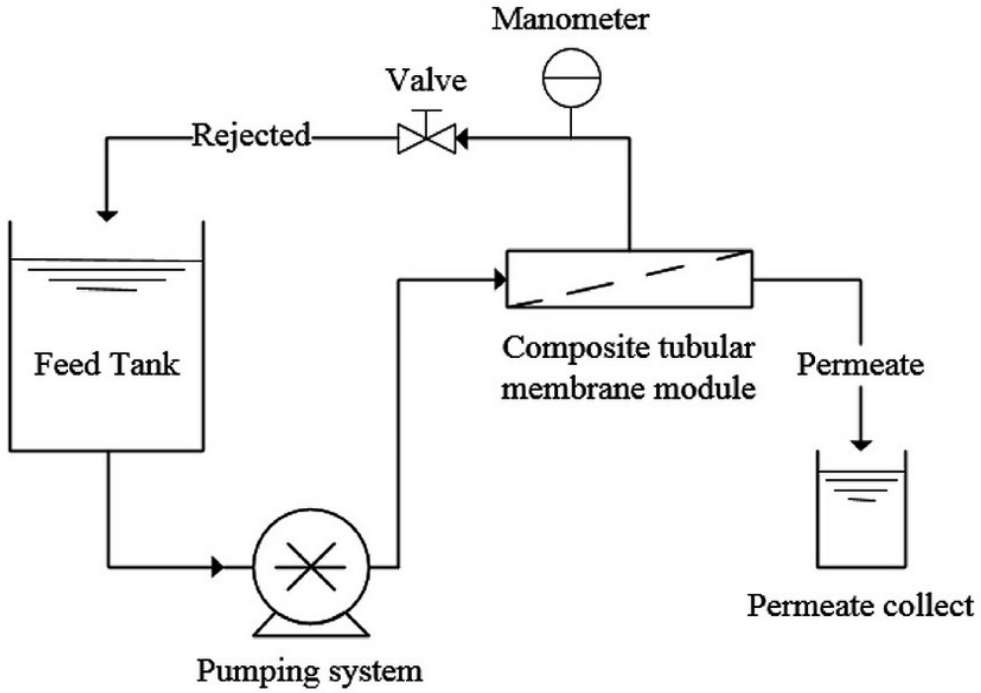


Figure-1: Process of Microfiltration (Dionisio et al., 2017)

Micro filtration of Surface Water for TDS removal:

Microfiltration plants are installed near river for the filtration of river water. River water is also highly turbid and has higher concentrations of TDS which makes it inappropriate for drinking purposes (Jamil et al., 2021).

The ***PVDC membranes*** which are highly porous. These are very advantageous because these can be operated at higher fluxes as compared to other types of membranes, lower pumping head and are resistant to fouling (Ferreira et al., 2021). These characteristics makes the system flexible for operation when treating turbidity and TDS. For surface water membranes of 0.1 µm are used. The overall turbidity is from 550 NTU to 0.1 NTU. It is observed that turbidity and concentration of TDS are decreased dramatically without any chemical dosage. This concentration is still inappropriate for drinking, so the water is re-mineralized **(**Uddin et al., 2021**)**.

Nano Filtration (NF)

The Nano filtration (NF) provides more quickly flow rate and consumes less energy as compared to the rivers osmosis, it can be utilized to recycle the wastewater with some exceptions the construction and performance of nanofiltration and reverse osmosis are very similar (Xing et al., 2022). The main difference is that the membrane of rivers osmosis is tight as compared to Nano membrane. It cannot eliminate the monovalent ions from water and also it works at the less feed water pressure (Ketharani et al., 2022).

Ultra Filtration

Ultra filtration membrane system is a technique which used for the removal of slightly larger particles such as silt and colloidal particles, bacteria and some viruses. Their pore size is in between microfiltration and nano-filtration ranging from 0.02 to 0.05 microns (Shehata et al., 2023).

Ultrafiltration can remove the microbial concentration from groundwater. The concentration of viruses and bacteria in feed effects the performance of the ultra-filtration membranes. The module which is developed for the removal of viruses; (ADV 41, CV-B5 and MS2 phage) contains multichannel membranes, a plug which allows in the in and out flow of water and a PTFE shell surrounding membranes (Arenillas et al., 2017). For the removal of viruses, the membranes are first rinsed and then their permeability is measured the flow of water is constant and the temperature and pH is maintained to avoid any decrease in efficiency (Jacquet et al., 2021).

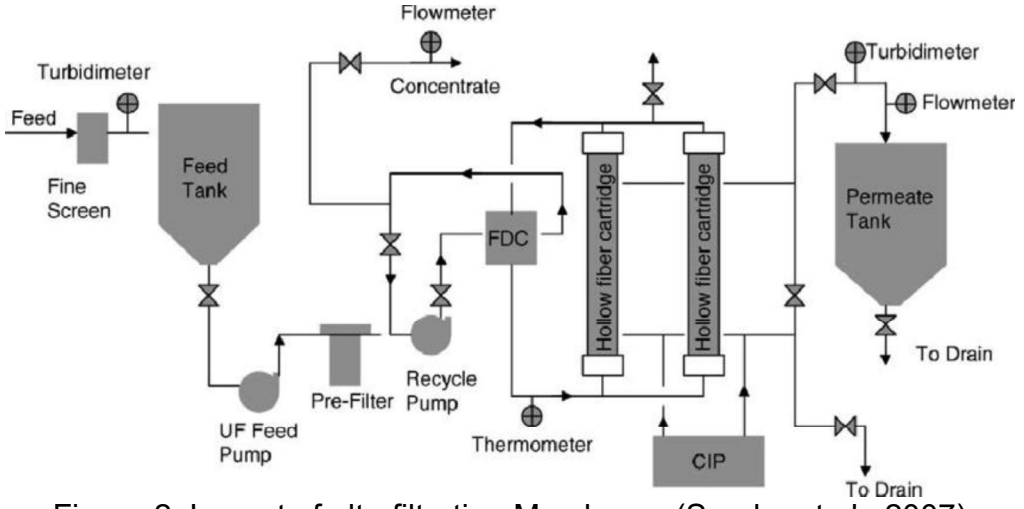


Figure-2: Layout of ultrafiltration Membrane (Sandro et al., 2007)

Reverse Osmosis

Reverse osmosis is a physical water treatment process which uses semi-permeable membranes which contains salty or turbid water (Ahmadpari et al., 2022). The power is applied on the membrane containing salt water and separates the solutes or dissolved solids and freshwater by creating a pressure gradient. In a reverse osmosis system, power source and hydro-turbines are applied across the membranes to control the osmotic pressure (Park et al., 2020). Reverse osmosis removes dissolved, solids, bacteria, colloidal debris, organics, nitrates, salts and colour (Shehata et al., 2023). Reverse osmosis converts the osmotic pressure to hydraulic pressure which is present between the solutions separated by membranes. This process physically separates the freshwater from saline water (Maki et al., 2023).

Working of RO system:

Water feed is first pre-treated to remove larger material and debris which can cause fouling of membrane or physical damage. Water then enters the RO membrane by applying pressure, an external source provides power which separates the saline water and freshwater called permeate. (Anis et al., 2019). By applying power, water molecules move through membranes by force and leaves salts and dissolved solids behind.

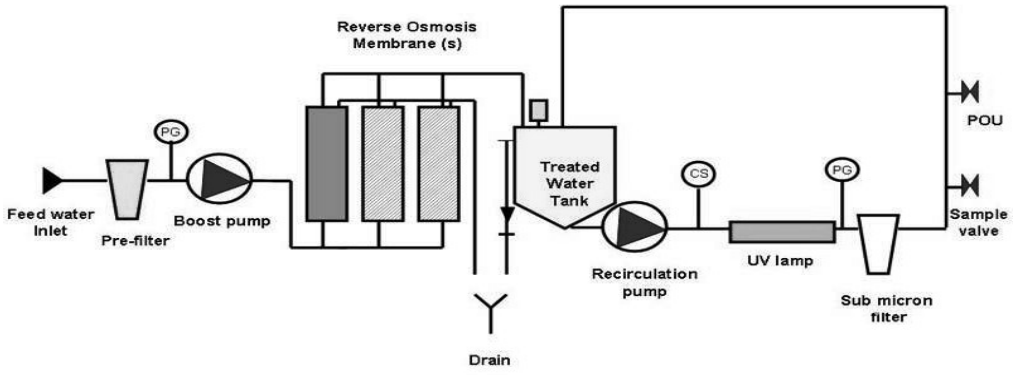


Figure-3: Working of RO plant (Renu et al., 2016)

Ozonation

Ozone is used in the treatment of drinking water because of its oxidation and disinfection quality (Kizi et al., 2021). Ozone is used in drinking water treatment firstly in Nice France in 1906 from 100 years ago. That is why Nice is called to be the birthplace of ozonation for the treatment of drinking water (Saravanan et al., 2022). There are three thousand Ozonation facilities in Europe where plants are used in the world to solve the issues of disinfection, taste order colour etc (Dubey et al., 2022). As compared to any other disinfectant chemical ozone rapidly destroys the bacteria and viruses.

Advanced oxidation process

For the treatment of the water the one of the most effective techniques is the oxidation process that does not produce sludge followed by the ozone dissolution into the oxygen and hydrogen peroxide. Ozone is a powerful oxidizing agent and its oxidation potential is 2.07V (Ding et al., 2019). It consists of one weak single bond and two strong double bonds that directly react with the water molecule in the form of ozone or it also reacts with the pollutants by forming the hydroxyl radical (Saravanan et al., 2022). The principle of ozone generation is based on the corona discharge method which consists of producing the high voltage inside the cool gas phase consisting of oxygen (Piskarev, 2021).

$$RH + OH^{\cdot} \rightarrow H_2O + R$$

$$RH + OH^{\cdot} \rightarrow H_2O + R$$

$$R + O_2 \rightarrow ROO$$

$$ROO + RH \rightarrow ROOH + R$$

Ozone is disinfection of chlorine resistant bacteria in drinking water

Chlorine is use as a disinfectant in the drinking water to kill the bacteria viruses and bacteria (Jefri et al., 2022). However, in aquatic environments most of the bacteria are insensitive to the chlorine. The chlorine resistant bacteria after the different disinfection treatment exist as a pathogenic spot and it is dangerous to the public health (Luo et al.,2021).

E. coli and Salmonella microbes inactivate in drinking water through the ozone and the ozone concentration is 2 mg/L reporting 5 and 6 log of salmonella removal after 45 second and 60 second contact time (Schwaner et al., 2023). The ozone in the oxidation reaction divide into the ozone and hydroxyl radical by the ozone decomposition the generates are enormous amount of oxidative radicals and also hydroxyl radical (Dai et al., 2024).

In the drinking water treatment plant abnormal growth of bacterial colonies was identified in 2014 in Southern China. These colonies do not control by increasing the amount of disinfectant such as sodium hypochlorite (Wei et al., 2020). The effluent index in the water is increased due to the total amount of bacteria which causes an issue in the quality of drinking water. In the study the ability of ozone as a disinfectant was investigated that it could alone in activate the seven strain of the fluorine resistant bacteria and its sports in water (Ding et al., 2019).

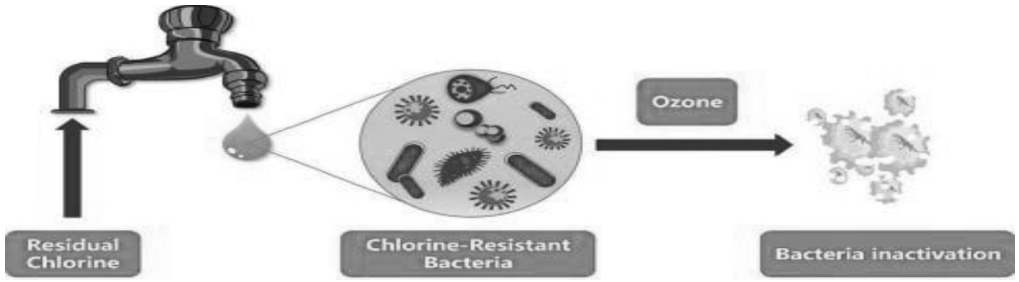


Figure-4: Disinfection of chlorine resistant bacteria by ozonation (Zhongqi et al., 2023)

Conclusion

Using groundwater for producing organic mineral water is an encouraging step towards the production of sustainable and healthy products. The possible benefits of utilizing naturally pure groundwater which is often rich in essential minerals and free of artificial additives are emphasized in this review. But it is important to guarantee the quality and safety using the correct method of treatment without compromising water natural characteristics. Using groundwater as a raw material in this manner has a lot of potential provided the increasing demand of environmental friendly

and organic products only when if it is carried out with the regard for the environment and scientific integrity.

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