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Drinking Water Contamination and Treatment Techniques

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Abstract

The earth's survival depends critically on water. Water is necessary for the body's metabolism as well as the synthesis, structure, and movement of cellular components, nutrients, and waste products. The contaminants in water disrupt the mechanism's spontaneity and cause long- and short-term diseases. In this review, the likely contaminations and their potential pathways are explored. Processes and methods to purify water are the product of ongoing scientific efforts. The review presents the technologies' concepts and potentials in an understandable way. Additionally, it contains some significant hybrid technologies and upcoming technologies that look promising.

Keywords: *Water Cleanup from Contaminants Technology used in hybrids*

1. Introduction

Fresh water availability, a gift from nature, governs a significant portion of the global economy. Water resources must be sufficient for human consumption, agriculture, recreation, and industry. occasionally natural or artificial contaminations deprive us of the gift and force us to face a far more difficult environment. It is common knowledge that access to clean water is essential for maintaining good health. Considering the development of technology and Freshwater supplies around the world are threatened by industrial development. The lack of access to freshwater affects one-sixth of the world's population (Elimelech et al., 2006). It is clear that problems with chemical discharge affect wealthy countries more than developing ones, who are more affected by agricultural sources. Waterborne infections and health issues brought on by contaminated water can be avoided by taking steps even at the household level. Getting everyone access to clean water is a difficult endeavor. Numerous techniques and technologies have been developed as a result of decades of ongoing research in this field (Shannon *et al.,* 2008).

Water contamination is a widespread issue everywhere in the world. These could be either (man-made) anthropogenic or geological (Nieuwenhuijsen and Fawell *et al.,* 2003; Khan et al., 2022). Higher contamination levels in water rarely have an immediate negative impact on health. Of fact, it depends on each person's susceptibility and the way the body is contacted. The nature of the geological components that the groundwater travels through and the quality of the recharge water determine the types and quantities of natural contaminants. The effects of these natural contaminations depend on the types and amounts of the compounds that groundwater passing through sedimentary rocks and soils may pick up, including Mg, calcium, and chloride, arsenate, fluoride, nitrate, and iron, as well as other substances. Water can get contaminated by naturally occurring substances that are present at unsafe levels (Charles et al. 2005; Liu et al. 2005; Alsokhny 2004; Rukah and Mulligan et al. 2001; Meenakshi and Maheshwari, 2006; Ghrefat et al. 2014). Other pollutants are created by-products of industry and agriculture, including dangerous chemicals, dyes, and substances like insecticides and fertilizers. Heavy metals like mercury, copper, chromium, and lead are just a few examples. Ground water pollution can result from improper handling, storage, or disposal of home chemicals such paints, synthetic detergents, solvents, oils, medications, disinfectants, pool chemicals, pesticides, batteries, gasoline, and diesel fuel (Anwar 2003; Kass et al., 2005) 2 million tons of sewage, industrial waste, and agricultural waste are dumped into the world's water every day, according to a UN assessment from 2003 (UN WWAP et al., 2003).Pathogens including bacteria, viruses, and parasites like tiny protozoa and worms are among the microbial pollutants. Human and animal wastes have the potential to disseminate these living organisms, willingly or inadvertently. By examining the water's colour, odour, turbidity, and favour, some toxins are simple to spot. The majority, however, are difficult to spot and need for testing to determine whether water is poisoned or not. As a result, the contaminants may have an unpleasant taste or odour, leave stains, as well as have an impact on your health.

Drinking water's colour is a physical trait that, unless it is highly concentrated, cannot be felt. For instance, groundwater with a high iron concentration appears reddish, and water with a high tannin concentration appears brown. Typically, it is assessed by contrasting a water sample with a colour reference. 100 colour units could be compared to the colour of light tea, while one colour unit has no effect on the water and is typically undetectable (Ligor and Buszewski et al., 2006). Despite the fact that odorless water is not always safe for drinking, odour is another sign of some contamination. Additionally, some contaminants have smells that can be detected even in minute amounts. Turbidity, is caused by the presence of silts, clays or sand, or organic, leaf particles or algae. Turbidity may act as a barrier for bacteria, preventing chemicals used for disinfection from attacking and killing the cells. Trihalomethanes and other potentially dangerous chemicals can be created when chlorine and organic materials are present. In comparison to groundwater sources, surface water sources typically have higher turbidity. A surface water source's turbidity ranges widely from 1 to 200 NTU (NTU: nephelometric turbidity unit). Children and adults have different levels of immunity to turbidity.

2. Contaminants Types

Basically, there are four categories of contaminants linked to water pollution:

1. contaminants that are inorganic
2. organic pollutants
3. Contaminants from the biological and radiological sciences.

3. Organic Impurities

The chemical parameters of the substance can also be used to detect contaminants. A naturally occurring contaminant, hardness of the drinking water largely depends on the geographical situation. It is brought on by significant calcium or magnesium content, and depending on what molecules are combined with magnesium and calcium, the hardness is categorized as non-carbonate or carbonate. The hardness is known as "carbonate hardness" if it is combined with carbonate ions (CO-3 2); otherwise, it is known as "non-carbonate hardness." Hardness between 300 and 400 mg/L is often acceptable for drinking purposes. Long-term exposure to salty water (TDS [500 mg/L]) can result in kidney stones, among other things. Inorganic contaminants such as fluoride, arsenic, lead, copper, chromium, mercury, antimony, and cyanide, in addition to carbonate and noncarbonated hardness, harm water resources. They may enter drinking water via industrial operations, natural sources, or plumbing systems (EPA US 2006; Nriagu et al., 1988). Fluoride can come from either natural or man-made sources. Fluoride levels in groundwater may rise as a result of weathering of fluoride-bearing minerals on the earth's crust, including fluorite, fluorspar, cryolite, fluorapatite, and ralstonite. The issue of fluoride concentration in the water is also made worse by the overuse of groundwater. Additionally, a number of pharmaceutical products (used to treat hyperthyroidism), medications, insecticides, tooth pastes, preservatives, disinfectants, super phosphate fertilizer, vitamin supplements, and other items are anthropogenic sources of fluorides. Children and the elderly who are still developing are particularly vulnerable to their effects. Fluoride has been linked to skeletal and dental fluorosis. It is linked to dementia in general, including Alzheimer's disease (Fawell et al. 2006; Susheela 1999; WHO 2008). Fluoride gets into the brain and makes it possible for aluminum to pass through the (BBB) increasing the risk for these diseases (Ram Gopal and Ghosh 1985). More than 20 developed and developing countries, including India, where 19 states are experiencing acute fluorosis concerns, have reported having excessive fluoride amounts in their ground waters (4.0 mg/L by the EPA) (Eswar and Devaraj 2011). Drinking water supplies can get contaminated with arsenic (MCL 0.01 mg/L) (EPA US 2006) due to natural soil deposits or industrial and agricultural operations (Smith et al. 2000). The world's largest mass poisoning incident is unquestionably due to arsenic contamination, particularly in Bangladesh and India (Chatterjee et al., 1995; Khan et al., 2003). Arsenicosis is a condition brought on by arsenic contamination of drinking water (Chen et al. 1988). Skin thickening and discoloration, stomach pain, nauseousness, vomiting, diarrhoea, tingling in the hands and feet, partial paralysis, and blindness are examples of non-cancer effects. Cancers of the, bladder, skin, kidney, lungs, liver, and prostate, nasal passages have all been linked to arsenic (Yoshida et al, 2004). The oxidation states [Arsenate (As V)] [Arsenite (As III) and level of methylation of arsenicals have a significant impact on the toxicity and excretion of arsenic compounds and their metabolites. As(III) is shown to be ten times more poisonous than As(V) (Pontius et al. 1994). Aside from seepage from landfills and some factories, agricultural runoff and mercury (MCL 0.002 mg/L; EPA US 2006) also find their way into drinking water. Mercury in water impairs brain functions, causes neurological disorders, stunts children's growth, induces abortion, and messes with the endocrine system (Clarkson 1992; Counter and Buchanan 2004). Copper (MCL 1.3 mg/L) (EPA US 2006) can enter water from naturally occurring deposits in rock and soil, however this happens more frequently as a result of corrosion in home plumbing. Long-term exposure can result in chronic liver or kidney damage, but short-term exposure causes only minor gastrointestinal irritation (Semple et al. 1960; Manuel et al. 1998). Chromium, which occurs naturally in the ground and has an MCL of 0.1 mg/L (EPA US 2006), is frequently used in the electroplating of metals and the leather industry. In most cases, runoff from abandoned mining activities and inappropriate waste management from these sectors cause it to enter the water. According to Ray (Arora) and Ray (2009), chromium exposure at high levels can result in dermatitis, respiratory issues, liver and kidney damage, and eczema. Cities with outdated water systems are increasingly experiencing a problem with lead (MCL 0.015 mg/L) (EPA US 2006). Municipal water systems contain lead that is slowly corroded by water, which can result in a variety of developmental problems in children and kidney problems and high blood pressure in adults and older people (Needleman et al., 1990). In the ground, antimony (MCL 0.006 mg/L) (EPA US 2006) is a naturally occurring substance that comes from the flame retardant industry.

Additionally, it is utilized in batteries, glass, ceramics, and explosives and fireworks. It might enter drinking water as a result of natural rock weathering, municipal, or manufacturing processes or industrial waste disposal. It influences blood glucose and cholesterol levels (Public Health Service, US 1992; Cooper and Harrison 2009a, b). Fertilizers are a source of nitrate (MCL 10 mg/L as Nitrogen) (EPA US 2006) contamination. It is present in sewage and waste products from people and/or farm animals, and these activities typically cause it to enter drinking water. Breathlessness and blue skin are some of the symptoms (Gupta et al. 2000). A mineral that forms tiny fibres in the environment is asbestos (MCL 7 million fibers/lit) (EPA US 2006). Due to asbestos exposure from water, the EPA has linked asbestos fibres in water to a rise in the risk of certain cancers (EPA US 2009a, b; Bull 2007). Food and soil are the main sources of selenium contamination (MCL 0.05 mg/L; EPA US 2006). It is used in electronics, photocopying processes, glass manufacturing, chemical production, pharmaceutical production, and as a fungicide and feed additive. Barium (MCL 2 mg/L) (EPA US 2006) occurs naturally in some aquifers that serve as supplies of ground water and has been linked to a number of detrimental health effects, including a loss of feeling and control in the arms and legs (Fan and Kizer 1990; Olson 1986). It usually dissolves from naturally occurring minerals in the earth and ends up in drinking water. When exposed to high amounts over the course of their lifespan, it can cause heart and circulatory system damage and is linked to excessive blood pressure in laboratory rats, among other animals (Wones et al. 1990; Brenniman et al. 1979). Drinking water that satisfies EPA standards carries little to no danger and is regarded as safe in terms of barium. In general, discharge from processing plants, runoff from mining operations and improper waste disposal cause Be (MCL 0.004 mg/L) (EPA US 2006) to enter water. When exposed to beryllium compounds for an extended period of time, people may develop cancer and sustain harm to their bones and lungs (Cooper and Harrison 2009a, b). The most common way that cyanide (MCL 0.2 mg/L) (EPA US 2006) enters water is through incorrect trash disposal. It has been demonstrated that cyanide poisoning results in damage to the spleen, brain, and liver of people (Ronald 1991; Khan et al., 2022).

4. Toxic Organic Substances

Pesticides, household garbage, industrial wastes, and other anthropogenic forms of pollution are the main sources of organic matter. Organic material contamination can result in major health problems like cancer, hormone imbalances, and Neurological disorders (Ram et al. 1990; Harvey et al. 1984). When chlorine from the treated drinking water mixes with naturally occurring organic materials, trihalomethanes (THMs) are created. Pesticide contamination comes from both agricultural and public health sources (Younes and Galal-Gorchev 2000; Damalas and Eleftherohorinos 2011). Pesticides used in agriculture and for public health have negative environmental effects when they are handled and applied improperly (WHO 2010). Pesticides are made to interact with several kinds of chemical reactions. Some pesticides with their maximum contamination levels (MCLs) are listed in (Adapted from EPA, US Protection agenc Table 1.

Table 1: Adapted from EPA, US Protection agenc

Pesticides	Nature	Maximum contamination level (MCL), μg/L
Carbofuran	Nematicide	40
Dalapon	Herbicide	200
Dibromochloropropane	Nematocide	0.2
Dinoseb	Insecticide/miticide	7
Dioxin	Herbicide	0.0003
Diquat	Herbicide	20
Endothall	Algicide	100
Ethylene dibromide	Insecticide	0.05
Glyphosate	herbicide	700
Methoxychlor	Insecticide	40
Oxamyl	Insecticide	200
Pentachlorophenol	Fungicide	1
Picloram	Herbicide	500
Simazine	Herbicide	4
Toxaphene	Insecticide	3

In the living body chemistry of the pest. Unfortunately, doing so exposes all pesticides to the possibility of interfering with non-targeted living things' metabolism. Pesticides mostly harm the liver and neurological system. Additionally, liver tumour development has been documented (Bolognesi 2003). Environmental organizations updated their MCLs (EPA US 2009a, b). The mixture contains certain pesticides with their MCLs (Table 1).

Solvents, organic chemicals like, benzene, trichloroethylene (TCE), toluene, styrene, and vinyl chloride, among others, as well as degreasers, adhesives, gasoline additives, and fuel additives are examples of volatile organic chemicals (VOCs) (Wehrmann *et al.,* 1996). Chronic health impacts from these VOCs include cancer, neurological diseases, liver, reproductive problems, kidney damage and birth defects (Brown et al. 1984).

One of the greatest classes of organic compounds that pose a growing environmental risk is dyes. A significant cause of non-esthetic pollution and eutrophication is the discharge of this contaminated water into the environment, which can lead to hazardous byproducts due to oxidation, hydrolysis, or other chemical reactions occurring in the wastewater phase (Prevot et al. 2001; Pagga and Bruan et al., 1986).

In addition to the aforementioned effects, chemicals found in water have the potential to have known or suspected harmful effects on the environment or human health. The term "Emerging Organic Contaminants" refers to these substances (Stuart et al. 2012; Lapworth et al. 2012 Pal et al., 2010, 2014). They are primarily carcinogenic endocrine disruptors. Several municipal, agricultural, and industrial sources and pathways are frequently used to derive these. The pharmaceuticals, such as antibiotics, analgesics, and anti-inflammatory drugs, come from chemical factories or hospital effluents. Lowest predicted no-effect concentration (PNEC) values for developing organic pollutants have been reported. Table 2 is a list of some of them (Pal et al. 2010, 2014).

5. Chemical Pollutants

Living organisms like bacteria, viruses, algae, or protozoa can all cause biological contamination of water. Each of them can lead to specific issues with water (Ashbolt 2004; Daschner et al. 1996). Algae are typically small, single-celled organisms. These are rather common and rely on nutrients, specifically phosphorus, in water. Usually, residential runoff or industrial contamination is where the nutrients come from. In addition to causing taste and odour issues in the water, excessive algae development also clogs filters and causes unpleasant slime growths on carriers. They can occasionally release toxins that can harm the liver (hepatotoxins), neurological system (neurotoxins), and skin (Anabaena, Aphanizomenon, and Microcystis) (Rao et al. 2002 Hitzfeld et al. 2000).

Bacteria are single-celled tiny organisms. Numerous harmful microorganisms exist, and water can contaminate them (Inamori and Fujimoto 2009). dysentery, Typhoid, and gastroenteritis, cholera can all result from them. Despite not being hazardous, some nonpathogenic bacteria (such as sulphur and crenothrix iron bacteria) can generate unpleasant tastes and odours (Rusin et al. 1997; Nwachcuku and Gerba 2004). Protozoans are similar in that they are tiny, single-celled organisms. Giardia and Cryptosporidium are two protozoans that are frequently found in rivers, lakes, and streams.

Table 2 lists some of the developing organic pollutants' lowest predicted no effect concentration (PNEC) values (Pal et al. 2010, 2014).

Table 2: Lowest predicted no effect concentration (PNEC) values for some of the emerging organic contaminants (Pal et al. 2010, 2014)

Compounds	Lowest PNEC (ng/l)	Compounds	Lowest PNEC (ng/l)
Antibiotics			
Trimethoprim	1000	Bisphenol A (making plastics)	60–150
Ciprofloxacin	20		
Sulfamethaoxazole	20,000		
Analgesic and anti-inflammatory			
Naproxen	37,000	PPOS (protective coatings, surfactants)	1100
Ibuprofen	5000		
Ketoprofen	15.6×10^6		
Diclonofenac	10,000		
Beta blockers			
Propranolol	500	Fipronil (termiticide)	250
Atenolol	10×10^6		
Blood lipid regulators			
Clofibric acid	12000	NP1EO (surfactant)	330
Gemfibrozil	100,000		
Benzafibrate	100,000		
Hormones			
Estriol	0.8	4MBC (sun screen)	560
Estrone	18		
Sucralose (sugar substitute)	93×10^4	DEET (mosquito repellent)	$5–24 \times 10^6$

containing animal manure or receiving wastewater from sewage treatment facilities These could result in headaches, diarrhoea, nausea, exhaustion, and dehydration. The tiniest living things capable of causing sickness and infection are viruses. Viruses like those that cause polio and hepatitis are frequently found in contaminated water.

6. Radioactive Pollutants

Radioactive elements are the source of radiological pollutants. The soil or rocks that water passes through, as well as some industrial waste, are potential sources of radioactive substances. Radiation may be released through the erosion of naturally occurring radioactive mineral formations (like a, b). Groundwater typically presents a worse concern for radiological elements (such as U226, Ra226, Ra228 and Rn228) than surface water. The chance of developing cancer is increased by all radiation pollution (Alireza et al. 2010; Haki et al. 1995). Table 3 is a list of some of the radioactive pollutants along with their MCLs.

7. Solving Techniques

Table 3: Radioactive contaminants and their MCLs (adapted by EPA, US)

Contaminants	MCL
Alpha particles	15 (pCi/L)
Beta particles and photon emitters	4 mrems/year
Radium 226 and Radium 228 (combined)	5 pCi/L
Uranium	30 ug/L

This theory, which was developed nearly 50 years ago, is more relevant than ever. Numerous water treatment techniques are developed in response to the challenge in order to provide uncontaminated water. Of course, the appropriate technology depends on the properties of the raw water (such as the kind and degree of contamination), the infrastructure (such as electricity, labour, and chemical availability), affordability/cost, and acceptability. or settling, boiling or Sedimentation or chemical treatment distillation (precipitation/coagulation/adsorbents), and filtration, disinfection are a few of the popular water purification techniques. The following are the procedures and methods for reducing contaminations.

8. Coagulation and Precipitation

One or more chemicals can be removed from a solution using the precipitation method, which involves adding reagents to make insoluble particles emerge. The term "solubility" governs the technique; that is, precipitation happens when the product of ion concentrations in the solution exceeds the solubility product of the relevant solid. It is among the easy ways to filter water. The addition of the chemicals creates particles that settle and purge pollutants from water. While the settling portion is dewatered and disposed of, the cleaned water is reused. The method is used to remove contaminants from water, including phosphorus, ferrocyanide, heavy metals, fluoride, arsenic etc (Matlock et al. 2002; EPA US 2000; Eikebrokk et al. 2006).

9. Distillation

According to Veil (2008), it is the most popular method of separation (http://www.msue.msu.edu). In this method of separation, heat is used to separate the combined components in water. It is based on the variations in the separate constituents' boiling points. The properties of the boiling point are dependent on the component concentrations. As a result, the vapour pressure properties of liquid mixtures are a factor in the distillation process. The fundamental idea is that adding heat energy increases vapour pressure. Due to the different levels of volatility in the combination, when the vapour pressure meets its surrounding pressure, the liquid mixture boils and distillation takes place.

Through this procedure, water is separated from inorganic materials like lead, calcium, and magnesium, among others, which help kill microorganisms. Organics with boiling temperatures under 100 C, however, cannot be effectively removed and may even concentrate in the product water. Technology for distilling water was initially created for industrial use. It did eventually arrive for domestic use, though. The carbon filter system must be added to the process because it is not particularly successful at removing organic pollutants, making the water truly safe to drink. The carbon filters must be changed frequently since they can easily turn into bacterial nidus.

Although distilled water is secure, it is unhealthy because it lacks the nutrients and minerals needed for drinking. Additionally, this technique for water purification moves quite slowly. A cumbersome water purification system is the end consequence after adding these two factors and the price of a carbon filter. Benefits:

10. Adsorption

Dissolved pollutants stick to the porous surface of the solid particles during this physical process (Jiuhui 2008). It is a result of surface energy and a surface phenomenon. All of the material's component atoms' bonding needs are met by the other atoms it contains. However, because the adsorbent's surface atoms are not entirely encircled by other adsorbent atoms, a physical attraction force develops. It may occur through chemisorption or physisorption (which derives from vanderwaals forces) (originates from co-valent forces).

The adsorbent systems can be added to the water supply either directly or through a mixing bowl. Adsorbents use a combination of physical and chemical processes to get rid of the substances that give water its colour, favour, and odour. All microporous substances can theoretically be utilized as adsorbents. The most favoured, nonetheless, are those with well-controlled and very porous surfaces (Yang 1997). It is helpful to employ porous substances like activated carbon, silica gels, alumina’s, and zeolites that have numerous cavities or pores with sizes as small as a few nanometers (Ali and Gupta 2007; Qu 2008).

11. Biologically Active Carbon Filtration

Another potential process with this bioremediation method is biologically active carbon. Granulated activated carbon (GAC) is used in the procedure as a water filter. The GAC media particles allow for the possibility of microbial (bacterial) colonization (Scholz and

Martin 1997). Actually, a "porous tangled mass of slime matrix" is how it is described (Weber et al. 1978). It is made up of microorganisms that are either embedded in an extracellular microbial organic polymer matrix or immobilized on the GAC (substratum) surface (Lawrence and Tong 2005; Ghosh et al. 1999). Cells of bacteria and fungi in biofilms secrete extracellular polymeric substances to create a stable, cohesive matrix that holds cells in a dense agglomeration (Lazarova and Manem 1995; Branda et al. 2005). Proteins, nucleic acids, lipids, and polysaccharides make up the extracellular matrix (Goodwin and Forster 1985). The activity of the biofilm is related to physiological changes that are linked to the promotion of specific genes (Dagostino et al. 1991), or changes in the bacteria's environment that increase the concentration of nutrients, oxygen, and enzymes in the area (Ghosh et al. 1999), or prevent the invasion of harmful or inhibiting substances (Blenkinsopp and Costerton 1991).

12. Disinfection

Physical and chemical methods of disinfection are separated. UV, solar radiation, and ultrasound are all included in physical treatment, whereas chlorine, iodine, and ozone are all included in chemical treatment (Kerwick et al. 2005).
The following list of therapy characteristics is provided:

13. Using Ultraviolet Light

The water that needs to be treated is exposed to germicidal ultraviolet (UV) radiation that is set up inside a low-pressure lamp during the ultraviolet treatment. The biological contaminants are exposed to UV radiation as the water passes the ultraviolet purifier, which harms the microorganisms' genetic components. This method uses ultraviolet water treatment to eradicate the bacteria (Hijnen et al. 2006; Bergmann et al. 2002).

14. Via Ozone

Ozone, or O3, is an unstable kind of oxygen and a UV radiation shield. But it works well as a disinfectant in drinking water (VonGunten 2003a, b). It easily releases oxygen, making it a potent oxidizer. Oxygen is converted to ozone by being exposed to UV radiation or a "cold" electrical discharge. It is simple to introduce oxygen into the bonds of organic molecules to generate aldehydes and ketones because of ozone's extremely high oxidation potential. When it comes to eliminating biological contaminants, such as pathogens, it is more effective than methods of chemical disinfection like chlorination. Actually, the organics in bacterial membranes are oxidized by ozone, which weakens the cell wall and causes cellular rupture. This exposes the organism to the outside environment, which results in the cell dying very immediately. Ozone also enhances clarity (clarifying iron, sulphur and manganese). Filtration is feasible because ozone treatment transforms the soluble Fe(II) and Mn(II) that aren't filtered under normal circumstances into insoluble Fe(III) and Mn(VII). Additionally, it lowers sulphur and other dissolved chemical concentrations as well as odour issues. Ozone has the fundamental benefit of leaving no disinfection residue in the water. When used as a disinfectant, ozone is produced and sprayed right away. Ozone is a large air pollutant, explosive, eyes, respiratory system and irritating to the skin. and mucous membranes. These drawbacks make it difficult to use ozone as a disinfectant. If the water contains little bromine, it may produce carcinogens.

15. Using Chlorine

In the disinfection process, chlorine and its derivatives, such as chlorine oxide, chloramine are the most prevalent strong oxidant. In terms of Giardia lamblia and Cryptospordium cyst-forming bacteria and protozoa, chlorine is effective (Gala-Gorchev 1996; Melvin et al. 1967). The usage of sodium and calcium hypochlorite is popular since handling chlorine gas is risky. It causes water to emit free chlorine. Another method to obtain chlorine solution is electrolytic. When chlorine is dissolved in water, free chlorine is released. Trihalomethanes and halo acetic acids are examples of potentially dangerous chemical byproducts created when chlorine combines with naturally occurring organic molecules in water. They have been linked to cancer (Univ. Florida Report 1998). Trihalomethane and halo acetic acids have yearly average maximum limits of 80 and 60 lg/L, respectively. The level of organics in the water, pH, temperature, and time all tend to cause them to rise. Reducing the organics is one strategy to lower the levels of trihalomethane and halo acetic acids (EPA, US 2012). It is therefore advisable to utilize it once the organic chemicals have been taken out of the water. Since ammonia is a food for bacterial growth and does not produce THMs or halo acetic acids, utilizing chloramine has the advantage of causing nitrification, which produces nitrates as a byproduct.

It is also a good oxidizing agent, much like chlorine. It quickly eliminates spores, cysts, viruses, and other harmful organisms of many different types (Punayani et al. 2006).

The basic -NH functionalities of amino acids and nucleotides react to generate N-iodo compounds, which is the mechanistic method of inhibiting protein function. As a result, crucial H-bond sites are blocked, fatally altering the structure of the protein. Oxidation occurs to the -SH groups in the cytoplasm. As a result, protein synthesis is unable to generate disulfide linkages. Reduced fluidity of cell membranes could potentially be caused by the olefinic double bonds of unsaturated fatty acids.

16. Through Hydrogen Peroxide

Despite its high oxidative and biocidal efficacy, it cannot be used to disinfect drinking water, but when combined with ozone, UV radiation, it can be (Andreozzi et al. 1999). The breakdown of peroxide, which results in the release of free oxygen radicals, provides the basis for the disinfection mechanism. The free radicals have the capacity to both oxidize and purify.

It does not produce leftovers or fumes, in contrast to other chemical substances. Peroxide has drawbacks in that it can irritate the skin, eyes, and lungs. Skin bleaching, painful blisters, and burns result from skin exposure.

In addition to the aforementioned, there is a current tendency to use titanium, Ag, Au, Cu, and Zn nanoparticles supported in solid matrix. Water flowing through the matrix won't have any bacteria in it because of the bactericidal effect (Savage and Diallo 2005; Li et al. 2008;).

17. Technology Hybrids

In reality, no technology can solve every issue on its own. Technology development is a dynamic process that advances gradually, with suggestions based on the greatest knowledge available at the time. However, the shortcomings of current technology might be fixed with new research and fresh findings. Because of this, the idea of combining different technologies, or in another sense, hybrid technologies, has emerged. Technologists and scientists have planned in accordance with the need. Let's start by talking about RO technology that works in concert. Feed pretreatment is essential for RO in order to prevent issues, such as fouling and membrane damage. Chemical addition, such as the addition of acids, coagulants/flocculants, and disinfectants, are traditional pretreatment processes. In the process of treating water, coagulation and flocculation (coagulants-flocculants) are dealt with. Treatment with chlorine is regarded as a disinfecting method and is frequently used. However, chlorination reduces the membrane's stability, necessitating a dechlorination procedure (sodium bi sulfite). Pumice, anthracite, gravels, and other granular media that can be combined are used in media filtration to treat water. The final pretreatment step uses a cartridge filter (made of papers, woven wire, and cloth) to retain particles between 1 and 10 lm in size. The "Silt Intensity Index" or SDI measure is crucial for evaluating the quality. Actually, by running feed water through a 0.45 lm filter paper in dead end mode at constant pressure, SDI takes the ratio of two flow measurements into account: one at the beginning and the other (Saha and Bhattacharya 2010).

Similar to this, coagulation as a pretreatment step is combined with water ion exchange therapy. The linked electrodeionization method, which combines electrodialysis with ion exchange, effectively deionizes water as the unit's electric current constantly regenerates the ion exchange membranes. The chemical regeneration used in traditional ion exchange systems is replaced by this electrochemical regeneration. For the purification of water, hybrid technologies like ED-RO or ED-RO with distillation have recently been developed, and these methods have numerous advantages over more conventional ones (Makwana et al. 2010; Saha and Bhattacharya 2010). The ED-RO methods use low energy usage, zero discharge, and excellent recoveries to desalinate brackish water. Since RO concentrates can be recycled through the ED system, reducing the feed flow rate, pre-treatment costs, and the reduced amount of effluent, ED-RO is a high recovery system. Therefore, combining the technologies and processes offers a solution to a problem that is becoming more and more crucial for both water conservation and water treatment. UV is frequently used as the last purification stage to remove impurities like germs and viruses in order to achieve better outcomes.

18. Upcoming/Expected Technologies

The nanotechnologists of the twenty-first century have now received the torch of the scientific endeavour in addition to the traditional technologies, and one of their greatest challenges is to establish this as a field. Technologies involving particles with a diameter of a few to hundreds of nanometers are referred to as nanotechnology. It is promising because it has a high surface area to mass ratio, which is a frequent feature of nanoparticles. Pollutants like 4-nitrophenol can be broken down by nanoreactive membranes (Dotzauer et al. 2006) and metal ions can be bound by them (Hollman and Bhattacharya 2004) in aqueous solutions. Silver nanoparticle-impregnated polysulfone membranes have been proven to be efficient at removing germs and viruses (Zodrow et al. 2009). Super chlorination is another cutting-edge method for producing clean, sterile water. It means that an increased chlorine dose will quickly kill and remove algae and pathogens from the water by oxidizing organic materials. The active substance that both promotes sanitation and exhibits reactivity toward organic contaminants is HOCl. When there is enough HOCl present, the contaminants can be quickly oxidized. However, mixed chlorine is generated when there is little HOCl present relative to organic contaminants. By raising the concentration of HOCl in the water, these mixed chlorine compounds can be oxidised. The break point is the temperature at which all organic contaminants oxidise (Bahadori et al. 2013). Sometimes superchlorination followed by dechlorination is required before using water in order to avoid the faults (namely corrosion, bleaching of hair and skin, and unpleasant odour). Since there are no opportunities to react with the sun's UV rays after sunset, super chlorination is done then.

19. Conclusions

The future of the oceans is uncertain. The topic of all nations is "Save water" due to the growing population and economy. Water quality and quantity should be treated equally. It is crucial that people are aware of the importance of "water conservation" and "safe drinking water," and this should be done. The amount of application, price, acceptability, and raw water parameters all affect the technological solution. Undoubtedly, sustainability requires awareness of the pertinent problems. Hybrid technologies are usually advantageous because each individual treatment technology has limitations. However, for the system to work at its peak, certain factors such as availability, selection, and optimization are crucial. The future of water treatment technology is highly profitable, and we can only hope that one day we will be able to meet the demand for "fresh water for everyone."

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