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Review Article

Optimizing Wastewater Treatment Performance System and Achieving Greater Efficiency to Improve Water Quality for Sustainability — A Review

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G. N. Nirmala[1], Surya Prakash[2]

1. School of Bioengineering, Vels Institute of Science, Technology & Advanced Studies (VISTAS), Chennai, India; 2. Vels Institute of Science, Technology & Advanced Studies (VISTAS), Chennai, India

Water is one of the main sources that are utilised all over the world. The scarcity of water is due to the rapid development of urbanization, population growth, agricultural growth, industrialization, and other environmental issues arising from chemical and biological contaminants in water that turn it into pollution. It is important to manage the waste to avoid environmental and social problems. Wastewater treatment is a method to turn wastewater into valuables that can be used in domestic as well as urban agriculture. It is estimated that nearly 38,354 million litres of sewage are generated per day, but only a few are treated. In wastewater treatment, several issues arise in the primary stage due to the clogging of solid particles that accumulate in the wastewater, and then the primary pretreatment is performed to reduce these solid particles. Mainly in industries, wastewater management is essential because the toxic effluent from industrial waste can affect the environment, be harmful to aquatic organisms, and lead to contaminants and pollution. There are various methods that can be used to treat wastewater, such as using algae technology to treat wastewater generated from industries through the growth of algae, which can then be utilised in biofertilizers, biofuel production, etc. Many applications are performed in water management, such as in agriculture, the chemical industry, the tannery industry, immobilization, nanofiltration, carbon capturing technology, microbial bioremediation, and other fields. We can see the advantages and disadvantages of these applications in this article.

Corresponding author: G. N. Nirmala, gnnirmala.se@velsuniv.ac.in

1. Introduction

On Earth, nearly 98% of water is sea water and 2% of freshwater which are used for drinking purpose. This two percent of water is being polluted by humans and industrial activities, which leads to contaminants [1].

The World Health Organization (WHO) report shows that 10 million people are dead because they use unsafe wastewater for drinking, sanitation, and other consumable purposes [2]. Due to the increase in population and industrialization, the rapid demand for water can lead to possible results of scarcity, droughts, and waste production, which are overcome by using the wastewater treatment and management system [3]. Wastewater management is important to reduce the depleting level of fresh water, and many countries, such as Africa, America, and Asia, use untreated wastewater for irrigation, while other countries, such as Saudi Arabia and Jordan, use treated wastewater for agricultural processes [4]. Nearly 80-90% of water is being used for irrigation, which may increase in the future, and lead to an increase in demand for water usage. It is efficient to save water and use wastewater recycling to manage the water for future resources [5]. In the past year, increasing wastewater epidemiology has been reported, as have severe respiratory syndromes detected in human sewage, which has been monitored. The wastewater contains a large amount of chemical and biological information, which is gathered by human health resources and management [6]. Nuclear wastes require fresh technological and nonsupervisory inventions to contain their singular capacity for contamination and accumulation. Radioactive by-products make clear the familiar temporality of less disquieting forms of waste, and the breakdown of waste is a time-consuming process. The same could be said of the average MSW tip, which can release methane with 25 times the likelihood of carbon dioxide through the decay of ordinary biodegradable trash. In this way, a casually discarded banana peel or the belch of an ordinary dairy cow both contribute to the earth's transition to a new geological time, also known as the Anthropocene [7]. In a circular economy, water is an important resource for various production innovations, such as agricultural irrigation technology. It only uses a linear model to prevent contamination and promote the circulation of water in a loop to increase energy production and nutrients that are extracted from water [8]. Approximately 2.45% of the land, 4% of water, and 16% of the population have drastically changed the water circulation in every state in India, which affects the overall capacity for controlling the water quality [5]. The major cause of contamination of water arises from multiple sources, such as industries, mining activities, sewage, chemical fertilizers, radioactive waste, and the rapid development of urbanization, which affects the environment, resources, and society and causes problems for various lifeforms [9]. In America, they treat only about 10% of the water from wastewater for cooking, drinking, and other purposes, spending billions of dollars to recycle the water due to more water crises, climatic changes, and overexploitation [10]. In many countries, fresh water is also contaminated due to deterioration and shortages. Wastewater treatment is an important source for conserving water for future uses. The methods of treating wastewater are mainly based on biomass and microbial conservation at a specific rate. In suspended growth technology, microbial activity is important for the conversion of wastewater into acceptable-quality water [11]. For many countries, urban wastewater treatment is an efficient method due to energy production and recovery processes during the production of purified clean water. A wastewater treatment plant is a sustainable technology for managing water for future purposes [12]. The reuse and recycling of wastewater are performed by various technologies to control or manage the water cycle. As in sewage water treatment, advanced techniques are used to produce purified water, which has been used for many purposes but not for drinking. [10] Many techniques are involved in the preliminary treatment for removing large solid suspended particles. These methods are expensive to treat the effluent, and this is overcome by performing non-conventional water treatment, which increases the demand for fresh water. These demands are due to inadequate sanitation disposal of wastewater and poor performance of wastewater parameters [13].

2. Wastewater Treatment Methodologies

The reduction in water level is due to economic growth and an increase in population density. These losses can be controlled by taking measures such as waste conservation efforts, reuse and recycling pathways for storing or controlling water, and rainfall conservation projects. Other than population growth, water scarcity increased sixfold in the 20th century, and pollution and contamination of water were mainly caused by oil spills, industrial and radioactive waste, global warming, and underground storage leakage [14]. Many other factors that affect the contamination of water are heavy metals, which are of great concern not only among chemists but also among the general population. In many industries, such as tanning processes in the textile and dyeing industries, heavy metals such as chromium are used as mordants and dyes for textiles. The effluent from these processes contains high levels of chromium, which is harmful to the environment and human health, and the sludge produced from these processes is one of the major drawbacks of precipitation [15]. To overcome the shortage or water crisis, there are three types of processes such as physical, chemical, and biological methods to treat water, and these are classified as different operations. The physical methods are membrane filtration, settling, media, adsorption, and UV processes. Whereas chemical methods perform coagulation, disinfection, exchange, oxidation, and softening processes, biological methods involve microbial biodegradation, phytoremediation, and bioreactor treatment to clean up the wastewater [16]. Based on classification, wastewater is mainly composed of solid and liquid waste, in which the solids have a higher capacity than the liquids and are in different forms, such as floating solids, dissolved solids, settling solids, colloidal solids, and suspended solids; the settling or floating solids can be treated but not the dissolved solids. Dissolved solids are treated by the sedimentation process [3]. For large-scale treatment of water, it is not convenient because it contains hazardous materials that affect the environment and human health in the disposal of waste in lakes, rivers, and oceans. In industries, chemical waste is treated in four processes that involve preliminary treatment, primary treatment, secondary treatment, and tertiary treatment [17]. The wastewater and its toxic materials in seas and on land surfaces are controlled and treated by environmental biotechnology for water by detoxification and traditional biotechnology to reduce waste by using biodegradable organic compounds, which are a natural method that contains microbial cells to clean up the toxic materials and are comparatively low cost than other methods. One of the most popular techniques in the 20th century was the immobilisation technology of microbial cells, which have more advantages and metabolic activity and are more resistant to toxic chemicals [18]. The methodology for treating sanitation in India is the measures taken by the governance analysis: a review of the law, policies, and regulations; structured qualitative interviews. These are the mixed qualitative methods used to treat the water [19]. The waste operation system consists of a whole set of activities related to running, treating, disposing of, or recovering the waste. The purpose of the waste operation system is to make sure that the waste matters are gathered from the source or position where they are generated and treated, disposed of, or reclaimed in a safe and proper manner. Modern waste operation systems, which developing countries aspire to, are all characterised by high recycling rates of clean, source-separated equipment. The waste operation system consists of four main corridors: The use of recyclable products or the placement of on-recyclable apparatus in the disposal of waste is more efficient for optimising the water. Each of these ways is again comprised of several subparts. Advanced waste operation systems include huge operation strategies to minimise environmental problems and save resources. Waste operation strategies are distributed into four areas with respect to their final disposition of the waste: minimization or prevention of waste generation, recycling of waste, thermal treatment with energy recovery, and landfilling. Minimization of waste is a top priority and is generally the responsibility of the waste patron [14].

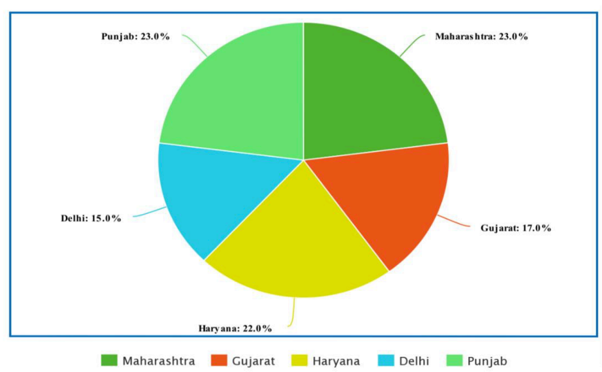

Figure 1. Performance of Wastewater Treatment in States of India

Wastewater refers to the solidified liquid wastes that are generated after products are obtained from households, commercial complexes, and industries. Wastewater has high pollutant loads, and the direct discharge of untreated wastewater into water bodies is creating lots of environmental issues. Due to its nutrient richness, wastewater is often used for growing algal species, which are capable of utilising nutrients from wastewater for their growth and development, which makes it an excellent treatment technique for wastewater. Recently, studies have been done for the reclamation of different types of wastewater. Out of them, a study by Valizadeh and

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Davarpanah (2020) showed that dairy wastewater treatment using Chlorella vulgaris obtained 42.57% chemical oxygen demand removal efficiency. In the 2022 wastewater treatment report, the performance of wastewater treatment in India shows the optimization of waste by using the sewage wastewater treatment method which is shown in the given Figure 1.

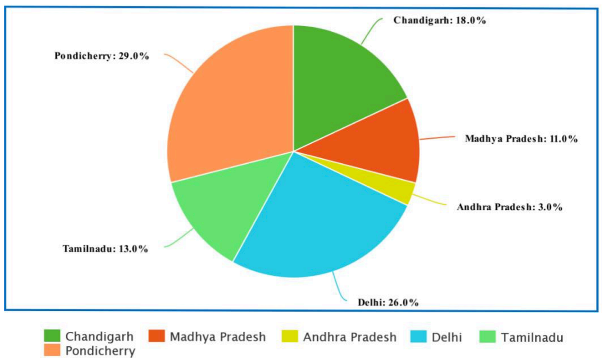

Figure 2. Reuse of Treated Wastewater in India

One of the states of Pondicherry uses a large amount of recycled treated wastewater which is shown in the given Figure 2. Another study report shows that the potential of various microalgal species for the bioremediation of textile wastewater was assessed. They found that the microalgae use dyes as a carbon source, which are further converted into metabolites, among other processes. The use of wastewater treatment plants for the treatment of wastewater is becoming more popular due to its cost-efficiency and eco-friendly properties. [20]

3. Process of Wastewater Treatment

To treat the wastewater before the life cycle assessment is performed [21], The LCA analyses the output and potential delivery of the product by processing it in the life cycle, or circulation. Wastewater treatment is carried out in the collection process of a settling aeration tank with a dual media filter, a chlorine dosing tank, a sludge tank, and a treated output water tank [21]. The selection of the system to be used will therefore depend on the wastewater characteristics. Each treatment has its own constraints, not only in terms of cost but also in terms of feasibility, effectiveness, practicability, treatability, environmental impact, sludge product, operation difficulty, pretreatment conditions, and the conformation of potentially poisonous derivations. Still, among the effective treatment processes presently cited for wastewater treatment, only a few are generally employed by the artificial sector for technological and profitable reasons. In general, the adulterant waste from backwaters is treated by physicochemical or natural processes, and it deals with exploration, concentrating on combined cost-effectiveness [9].

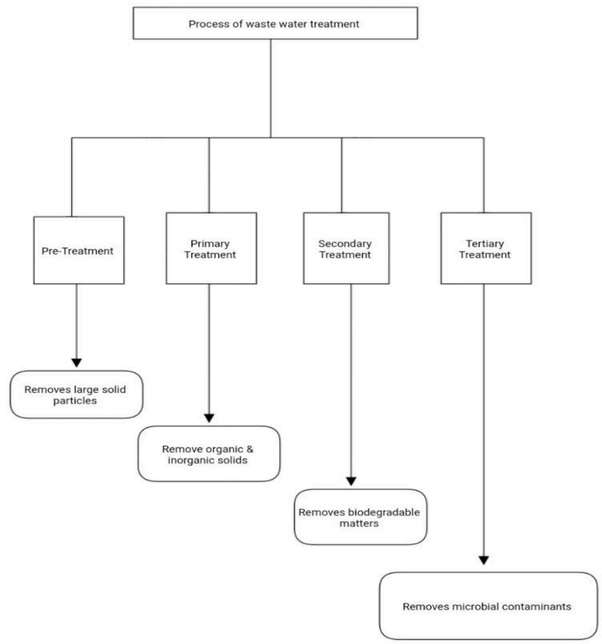

Figure 3. Process of Wastewater Treatment

The wastewater treatment is carried out in four steps: preliminary treatment, primary treatment, secondary treatment, and tertiary treatment [17] (Figure 3). The most important process is to remove contaminants from emerging factors. These are removed by ultrafiltration or advanced oxidation, which are performed in tertiary treatment, and 50% of contaminants are removed in primary and secondary treatment by the action of activated carbon performed in the removal of sludge in sedimentation [22]. The first step in wastewater treatment is preliminary treatment, or "pretreatment," which is carried out in constructed wetlands, which are built to remove the suspended large solid particles in the wastewater for a quicker purification process. These constructed wetlands can be used in a wide range of treatment processes, such as domestic, industrial, and municipal wastewater treatment and energy-efficient treatment technology. The methods of pretreatment of wastewater are septic tanks, coagulation or flocculation, waste stabilisation ponds, and biofilters [13]. Primary treatment is generally practised in irrigation for agricultural techniques, in which the toxicity and heavy metals are removed during this process and taken into secondary treatment [23]. In this treatment, organic and inorganic solid waste materials are separated by physical processes [17] (Figure 3). Wastewater treatment mainly focuses on the removal of carbon, nitrogen, phosphorus, and other contaminants in the water [24]. The secondary treatment of wastewater performs the removal of biodegradable matter in suspended liquid, and the tertiary treatment is the final process in wastewater treatment, mainly treating microbial contaminants in residual disinfection by chemical process [17].

Figure 4. Steps Involved in Wastewater Treatment

This stage helps exclude the dissolved organic matter that escapes primary treatment. Microbes consume the organic matter as food, converting it to carbon dioxide, water, and energy for their own growth. Fresh settling to remove further the suspended solids also follows the natural process. With secondary treatment, nearly 85 percent of the suspended solids and natural oxygen demand can be removed (Figure 4). The process of secondary treatment can also reduce the carbonated pollutants that are specifically settled in the settling tank of the wastewater cycle. This sludge can be fed as a substrate with other wastes in a biogas factory to produce biogas, an admixture of CH_4 and CO_2. It generates heat and electricity for further energy distribution. The leftover, clear water is also reused for nitrification or denitrification, for the junking of carbon and nitrogen. Likewise, the water is passed through a sedimentation receptacle for treatment with chlorine. At this stage, the water may still contain several types of microbial, chemical, and essence impurities. Thus, to make the water applicable, e.g., for irrigation, it further needs to pass through filtration and also into a disinfection tank. Then, sodium hypochlorite is used to disinfect the wastewater. After this process, the treated water is considered safe to use for irrigation purposes. Solid wastes generated during primary and secondary treatment processes are reused further in the gravity-thickening tank under a nonstop force of air.

The solid waste is also passed into a centrifuge dewatering tank and eventually to a lime stabilisation tank. Treated solid waste is attained at this stage, and it can be processed further for several uses, such as landfilling, treating diseases, and building structures. than the actuated sludge process of wastewater treatment, there are several other styles developed and being used in full-scale reactors similar to ponds (aerobic, anaerobic, facultative, and development), trickling pollutants, anaerobic treatments like over-flow anaerobic sludge mask (UASB) reactors, artificial washes, microbial energy cells, and methanogenic reactors [4].

In certain cases, a final or tertiary treatment can also be demanded to remove the remaining adulterants or the motes produced during the secondary sanctification (e.g., the jilting of mariners produced by the mineralization of organic matter). Still, the use of tertiary treatment in Europe is limited, though it may be necessary in the future if new restrictions are applied. The main tertiary treatments employed to date at a multitudinous artificial spot are adsorption using actuated imitations (AC), ion exchange, membrane filtration (ultrafiltration, hamper osmosis), advanced oxidation, and constructed washes (CW) (Figure 4). In Europe, the ultimate applications of the CW are for domestic sewage and external wastewater treatment. Still, the diversity of CW configurations makes them versatile for treating artificial backwoods [9].

Tertiary treatment filters the water to remove whatever solids remain, disinfects it with chlorine, and removes the swab. In California, tertiary-treated water is called "reclaimed water" and can be used for irrigation or sanitation. For circular drinkable exercise, recycled water that ultimately becomes drinking water undergoes advanced water technology, is tertiary-treated, and also spends time in groundwater or face water, similar to a force, before being transferred to drinking water inventories. One of the techniques of waste treatment is microfiltration, which reduces the remaining part of the solids in the water tank. Next, reverse osmosis, which applies pressure to water on one side of a membrane, allowing pure water to pass through, eliminates contagions, bacteria, protozoa, and pollutants. The water is also disinfected by ultraviolet light (UV) or ozone and hydrogen peroxide. Eventually, it's added to groundwater or faces water budgets, where it stays for an average of 6 months before being further purified by natural processes. Once drawn from the groundwater or forced, the recycled water goes through the standard water sanctification process all drinking water undergoes to

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meet US Environmental Protection Agency norms. [10] In the wastewater treatment sector, natural processes deal primarily with organic contaminations. Microbial-based technologies have been used over the last century for the treatment of domestic liquid waste sludge. The development of these technologies has led to excellent processes for the destruction of waste ingredients that are readily biodegradable under aerobic conditions. Thus, processes analogous to those used for conventional domestic wastewater treatment have been applied successfully to the treatment of numerous artificial wastewater. Aerobic declination in the presence of oxygen is considered to be a fairly simple, affordable, and environmentally sound way to degrade waste. Answerable organic sources of biochemical oxygen demand can be removed by any feasible microbial process, whether aerobic, anaerobic, or anoxic. Still, aerobic processes are generally used as the primary means of BOD reduction in domestic wastewater because the aerobic microbial responses are generally 10 times faster than anaerobic microbial responses. Thus, aerobic reactors can be erected fairly small and open to the atmosphere, yielding the most provident means of reducing biological oxygen demand (BOD) [17].

3.1. Industrial Wastewater Treatment

Industries produce waste in different varieties, and this waste contains harmful toxic substances that pose high threats to the environment and living things, they reduce the risk of contamination by reusing and recycling and using strategic methods to treat the hazardous waste [7]. The circular economy is focused on streamlining framework capabilities by decreasing the assets getting away from the framework. advancing towards all the more circular Shrewd urban communities' idea is a commonsense and adjusted blend of social, financial, biological, and other significant fields for a typical feasible turn of events. Biological urban communities overall offer a shared objective for treating the effluent waste from the industries. The Wastewater Treatment System, which has become a significant nexus of Shrewsbury, shows the keen wastewater framework idea in which a wastewater treatment plant is not only designed to treat wastewater with productivity that permits emanating reuse but also to create energy and produce compost. An ever-increasing number of urban communities around the world are executing savvy ideas in their space. A model is Sweden, where the City of Boras has created a project in which wastewater treatment plant waste will be gathered with the neighbourhood power plant and will contribute sustainable fuel for a city power plant. The reusing model is to change the energy of the city's waste streams into inexhaustible resources [12]. The use of 3R (reduce, reuse, and recycle) technology can reduce the waste that is generated from the industries (sludge and effluent wastewater) and is considered to be useful in the production of energy resources, feedstock materials, and treated water may be useful in irrigation systems [25].

3.1.1. Effects of Wastewater Treatment

The treated municipal waste is the main sustainable source of irrigation in the agriculture field because of a lack of water, water deficiency, an increased population, and the large production of wastewater. This treated municipal waste is a non-conventional resource for treating water deficiency. In 2009, they conducted an experiment to treat the municipal waste in Iran as a result of increased water irrigation, which increased stem height, diameter, and leaf size and improved soil structure, permeability, and fertility by irrigation of treated wastewater, thus improving crop cultivation and reducing water shortages [26].

In the agricultural sector, the main drawback in this field is drought, which passes throughout the world, and above 70 percent of wastewater is being used in developing countries due to population exploitation. The reuse of wastewater in agriculture has great benefits because it contains essential minerals like nitrogen and phosphorus, which help improve the recycling of nutrients in wastewater and minimise the use of fertilizers. The growth of leafy vegetables such as cauliflower, cabbage, and spinach had a greater response to growing in wastewater than radish growth [27].

The life cycle assessment (LCA) of wastewater treatment contains several significant features in the reuse of wastewater, which follows various techniques such as aerobic or anaerobic, chemical or combined chemical and biological. This study shows how energy generation from renewable sources minimises the depletion or emissions of pollutants and fossil fuels. In the treatment of wastewater, the energy flows and material modelling processes are done through software tools with the Eco-invent dataset v3.0, which is a convenient tool for managing waste production, and the methods and framework of these techniques are led by the International Standard Organization (ISO) [21]. Another study shows the use of chlorella sp. has great efficiency in removing chemical oxygen demand (COD) in primary municipal wastewater treatment by the growth of algal cultivation in batch culture [28].

3.1.2. Domestic Waste

Domestic waste treatment ensures that all household sewage is properly treated to make it safe, clean, and suitable for release back into the environment, lakes, or streams. Home sewage systems are designed to treat all of the liquid waste generated from a residence. Possible contaminants in household wastewater include disease-causing bacteria, infectious viruses, household chemicals, and excess nutrients such as nitrate. Domestic waste consists of two main factors: one is grey water, which is from kitchen sinks, washbasins, laundry washing, showers, and home-based food-processed wastewater, and the other is black water, which is from toilets and urinals.

Domestic sewage waste can be treated by using hydrolytic acidification or the biological contact oxidation method, which reduces the cost of running water resources. This process is used for 30 days of BOD removal, with an average removal rate of about 85.41 percent. The activity of microorganisms has a great impact on removing biological oxygen demand (BOD) through the metabolic activity of microbes under aerobic conditions, and then this treatment can also pass for the removal of nitrogen and ammonia. This process is done by the notification of nitrifying bacteria to remove the nitrogen in the suspended waste matters for a long period of time to break the ammonia approximately (5-30 days) for deep treatment, and then it further goes into the turbidity removal stage, which accounts for maintaining the environment's water quality [29].

3.1.3. Coagulation

The new widely used method of primary treatment is coagulation, which is the simplest method of removing colloids, suspended particulate matter, and solid impurities. To achieve a complete and efficient treatment of water, methods based on chemical or natural coagulants are used. Natural coagulants are composed of carbohydrates, proteins, lipids, polymers of polysaccharides, and amino acids that are extracted from natural sources such as microorganisms, animals, or plants and have greater environmental benefits, are more eco-friendly, and are less toxic than chemical coagulants. Charge neutralisation and the formation of polymer bridges are the activities of coagulation. The coagulation process is performed in preliminary treatment using the PAC polymer to partially remove the suspended solid particles [23]. Chitin is a cellulose-like biopolymer that acts as a charge neutralizer, forms bridges, and is efficient in low concentrations, producing little sludge, which is degraded by microorganisms. The chemical coagulants are some chemical salts such as $Al2(SO4)3$ and $AlCl3$, which are widely used and highly efficient for chemical coagulation. This method of treating waste is simple and efficient for treating solid, suspended waste. [5]

3.2. Moringa Stenopetala

Another important effect of the Moringa stenopetala seed extract is that in treating wastewater effluent from the tannery industry, it removes 18.47% of the concentration of heavy metals, specifically chromium (Cr) metal ions. Moringa stenopetala is a plant that grows in Africa. Compared to other species, it contains more proteins and fewer lipids, and its seeds can be used as reagents to remove textile colour or as effective coagulating agents to remove wastewater [30]. These extracts of Moringa stenopetala seed have a high active site to absorb the heavy metals and chromium ions that are present in tannery industrial waste effluent, and the efficiency of the seed extract depends on pH value. At more acidic conditions, the adsorption of chromium is very low in concentration, and in basic conditions, it adsorbs more chromium (Cr) heavy metal ions. Moringa stenopetala is cost-efficient and eco-friendly for treating the effluent of wastewater from the tannery industry [15].

3.3. Nanocomposite Membrane

For removing the wastewater, using nanofiltration of polyamide membranes removes 99 percent of the waste by reverse osmosis and nanofiltration processes. The polymer nanocomposite membranes consist of two types: blend and film-based nanocomposite. The blend membrane has high stability, elongation, and hydrophilicity. These thin-film nanocomposite membranes have a greater influence on the purification of wastewater due to their hydrophilicity, thermal stability, selectivity, permeability, and thermal resistance. The carbon nanotubes present in polymer nanocomposite films had a significant role in the removal of heavy metal ions during acid drainage [2].

3.3.1. Algal Technology

Algae are rich in carbohydrates, lipids, proteins, and pigment and are valuable in producing products like biodiesel, biochar, and biohydrogen. The algae can be used in the treatment of wastewater. This waste mostly contains minerals and is rich in nutrients, which are used for the growth and development of algae. This process is eco-friendly and cost-efficient. Chlorella vulgaris has a 42-57% COD removal efficiency, and it removes 50% of nutrients and 98% of ammonia and waste from various industries by using algal technology. The use of algae in untreated industrial waste can be used to generate energy and is environmentally sustainable [20].

The performance of pilot-scale high-rate algal ponds can be used in treating wastewater in the primary treatment stage because they have high efficiency, biogas production potential, and biomass productivity. Microalgal photosynthesis generates oxygenation in the pond, which utilises the nutrients. Biomass in urban waste in the ponds plays a vital role by growing to treat the wastewater that is emitted from the industries [28].

3.3.2. Cyanobacteria

The idea of using cyanobacteria for wastewater treatment has great benefits in various steps. tests were carried out by Caldwell (1946). In the early 1980s, the use of cyanobacteria in wastewater treatment increased due to its high mineral absorption capacity. In this regard, cyanobacteria represent an impressive surrogate that can be used for bioremediation purposes due to their highly flexible metabolic machinery. Mass culture of cyanobacteria is cheap and convenient compared to fungi and bacteria. Surgery The removal of cyanobacteria in wastewater treatment is a current need. Wastewater treatment systems using photosynthetic microorganisms have recently emerged as a promising alternative to conservative biological processes. However, cyanobacterial treatment of wastewater discharged from various locations has attracted significant research interest over the past decade, with promising results for both organic and inorganic emissions. This process offers many advantages, such as lower running costs, lower CO_2 emissions, and higher costs as photosynthesis replaces the mechanical requirements of aeration. The use of chemical fertilizers for microalgal growth is prevented as microorganisms utilize the nutrients in the wastewater. In addition, the obtained biomass can be used as a production resource. Biofuel production. Cyanobacteria biofilms also show great potential in wastewater treatment. Biofilm matrices protect microbial inhabitants from external environmental stresses [31].

3.3.3. Pollution and Treatment

Due to rapid industrialization, many water pollutants still need to be analysed. New chemical compounds are being developed and end up in water bodies from raw sewage waste, septic tanks, and effluent from processing industries [1]. The disposal of waste containing hazardous waste materials into rivers and other water areas can pollute surface and underground water and soil, which affects the overall environmental stability, human health, and livestock. These impacts are huge and mainly depend on the compositions (physical, chemical, and biological) of the produced water, and the organic and inorganic compounds in the water are highly toxic to the environment and society [32]. When waste operation structure is limited, people and waste may mix in ways that reflect poorly on the humanity and quality of the former. In exile camps, for illustration, inhabitants are kept in a state of suspension between political administrations in order to admit humanitarian aid and protection from conflict, thus representing political dirt Camps are generally planned by the UNHCR in order to promote hygiene and health above all; in practise, however, sloppy waste management can expose inhabitants to illness and complicate the environment. For waste to end nearly anywhere else, regardless of what is done with it, labour is required. Further humble acts of waste operation occur outside the aegis of any municipality, province, or state. kinds of cleanliness of lived-in places, social spaces, and bodies have become formalised and require constant maintenance. On the one hand, there are caretakers and domestic workers, paid and unpaid, who routinely expose themselves to forms of pollution in order that they might keep others clean [7]. Many industries that produce batteries, heavy metals, metallurgical processing, and petrochemical processing industries release toxic or harmful waste into the water bodies, such as copper, zinc, nickel, lead, and cadmium, which pollute the water system and have noxious effects on the nervous and cardiovascular systems [33].

Produced water is an admixture of inorganic and organic composites. Saltiness is a general trait of produced water. Saltness or "swab attention," described as TDS, can vary in produced waters from 1.000 to 400.000 mg/L. Environmental effects of produced water mariners can be in all regions where oil and gas have been produced. Sodium is a major dissolved element in most produced waters, and it causes substantial declination of soils through alteration of tones and soil textures and posterior corrosion. High sodium situations contend with calcium, magnesium, and potassium for uptake by factory roots; thus, redundant sodium can prompt shortages of other cations. Elevated situations of sodium can also beget poor soil structure and inhibit water infiltration in the soil. Produced water mariners feel to have the most wide-ranging goods on soils, water quality, and ecosystems. It's a major contributor of toxins. Saltiness is more advanced in yield water than some ocean water, which could affect submarine destruction in fresh water. Inorganic ions (e.g., sodium, potassium, calcium, and chloride) are not of concern in produced water discharges to the ocean but are of environmental concern when the treated water is discharged to land or faces fresh or brackish water. The produced water content that has the implicit potential to beget damage to the terrain is the organic material. Organic matter in yielding water lives in two forms: dispersed oil paint and non-hydrocarbon organic material. Dispersed oil painting is made of small, separate driblets suspended in water. Non-hydrocarbon organic material is dissolved in the water. Dispersed oil paint and driblets don't precipitate at the bottom of the ocean but rise to the surface. Unpredictable or poisonous composites dematerialize. These increase the biochemical oxygen demand (BOD) of the affected water. Worldwide exploration has proven that produced water backwaters are associated with high levels of natural oxygen demand and chemical oxygen demand (COD), which are generated from composites of acids. Nonpolar organics from different sources of produced water are poisonous. Produced water toxins can be expressed as acute or perpetual toxins. Acute toxicity can be measured by the LC50 test, but long-term effects, or perpetual toxicity, are more delicate to quantify [32].

There are various sources of water contamination, e.g., homes, mines, and infiltration, but one of the topmost remains the large-scale use of water by sedulity. The artificial wastewater group can be subdivided into cooling water, washing effluent, which has a variable composition, and manufacturing or process water (biodegradable or potentially toxic). In general, process waters (i.e., wastewaters or backwoods) are more complicated. Wastewater differs from drinking water sources (generally lakes) in one important way. The contaminant situations in most drinking water sources are fairly low as compared with contaminant situations in wastewater derived from industrial-type exertion. Still, their toxicity is consistent with their composition, which in turn depends on their artificial origin. In general, the problems encountered during wastewater treatment are truly complex, as the effluent contains pollutants of various types depending on its origin. So, there are several types of wastewater to treat, each with its own characteristics that play a part in the treatment of wastewater processes [34].

Wastewater trouble operation approaches, central governmental programmers and acts in the compass of wastewater trouble operation, sanitation, and water operation in India have been linked through a literature review predicated on government databases and certain rules and policies. The Karnataka State Policy on Communal Wastewater Exercise was linked through website discussion and considered a reference in relation to central regulations. Central governmental regulations for pollution control measures in the wastewater sector in India were linked through a literature review based on government databases and website disquisition. All historically applicable wastewater discharge morals for STPs in India were considered for the assessment. International regulations on wastewater discharge and exercise morals were informed by representatives of the international INNOQUA design, with a further extended literature review predicated on website discourse. The range of named countries for assessment was predicated on their development status, climatic conditions, and water loss status in order to allow a broad overview and compare them to their original conditions or limiting factors. Qualitative interviews with former and present governmental officers at central and state positions in India were carried out in order to pierce published paraphernalia and missing information on the morals setting process, the connection of wastewater discharge and combined morals due to observed inconsistencies during the assessment process, the reasons for observed changes in morals over time and related inconsistencies in applied and recommended measures among governmental institutions at central and state positions, and investment and development plans in the wastewater sector. In India, they identified the municipal and several industrial wastes being mixed into rivers and water-lying areas that are highly polluted in the region of the Ganga and

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Yamuna rivers the mixture of waste into the water and reduce the water quantity and quality in the environment and in human resources [35].

3.3.4. Methods to Treat Water Pollution

Contributing to the diversity of monoculture is the number of different culture systems employed to produce an increasing number of species. A wide variety of culture systems, analogous to an earthen pond and limited-flux culture systems, flow-through tanks and courses, recirculating systems, integrated systems, and polyculture, are employed to meet the product conditions of the dressed species and maximise the resources available in the region. Each culture system has aspects that affect the product viscosity and potential for complaint, as well as how antibiotics and antimicrobials are administered and handled for uptake by the species and excretion into the terrain. An arising concern not only for the terrain but also for humanity, several discourse studies have been conducted to find effective natural, chemical, and physical ways to remove antibiotics available in wastewater backwoods and natural waters. Several reviews were published, covering small or special sections of environmental pollution caused by chemicals. However, the ultimate goal of these studies has been to remove the contaminants coming from industrial effluent, livestock, and veterinary practices. There is truly little dissertation done specifically for monoculture wastewater treatment against harmful waste. Although the same styles can be applied in a monoculture setting, field-specific studies or disquisitions are necessary for several reasons. For example, the concentration of antibiotics, the form of antibiotics and their metabolites, which will be excreted after being digested by fish, the retention time, and the cost may be significantly different from other types of wastewater treatment shops. Infelicitous matters discharged from monoculture husbandry may affect the terrain by introducing antibiotic-resistant pathogens that can be acquired, developed, and transferred among the original microorganisms in the terrain in both brackish and seawater ferocious monocultures. Water is considered a limited resource and always leads to the exercise of water after one culture cycle to another culture cycle to treat the waste [36].

3.3.5. Immobilized Microbial Systems

A number of benefits exist for immobilised microbial systems over free ones at the moment. The employment of this technology in research is among its most promising applications. To reduce environmental contamination, support the biodegradation of several hazardous substances. Although mobile technology in the environmental sector is still in its infancy, the outcomes to date are encouraging. The cells that have been immobilised will be helpful in the treatment of garbage by allowing hazardous compounds to degrade into nutrients, biomass, and CO2 through their intermediaries. An absence of internal and external mass transfer barriers caused immobilised cells to exhibit a faster rate of biodegradation. Including fungus biomass in an engineering process can be accomplished using immobilised cells. [18]. The other treatment of wastewater is already discussed in these previous pages.

3.3.6. Carbon Capture Treatment

The typical goal of wastewater treatment is to eliminate pathogens, suspended particles, carbon, nitrogen, and phosphorus so the effluent complies with environmental quality standards. Given that the protection of the original underwater terrain and public health will continue to be of the utmost importance for the wastewater segregation process, a carbon capture unit must be realized in this terrain without compromising treatment effectiveness. A carbon capture unit may provide direct original benefits through product valorization and additional alkalinity for better water chemistry and treatment, going beyond global environmental benefits if effectively integrated with wastewater structure and treatment limits. Through a quantitative examination of one specific script with integrated operations of treatment and CCU, we analyze emerging technologies and procedures that may progress carbon capture from wastewater and show the environmental and financial consequences of this integration. intern for microbial electrolysis. Wastewater serves as the electrolyte in this system's microbially assisted water electrolysis. In the anode chamber, electroactive bacteria (EAB) in particular oxidize biodegradable material to create electrons, protons, and carbon dioxide (CO2). The anode accepts electrons, which are then sent via an external circuit to the cathode, where they convert water to form H2 and OH-. Wollastonite, CaSiO3, and other plentiful silicate minerals, as well as waste equipment, can release substance ions (Ca2, Mg2, and others) when exposed to the H-rich anolyte (for illustration, coal cover ash) [24].

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3.3.7. Nanofiltration

Nanofiltration is the most recent pressure-driven membrane technique for liquid-phase separations. Due to lower energy consumption and improved flow rates, nanofiltration has taken the place of RO in multitudinous activities. The parcels of nanofiltration membranes are situated between those of porous ultrafiltration (UF) membranes and pervious RO membranes, where transport is controlled by a result-diffusion medium (where separation is generally assumed to be due to size rejection and, in some cases, charge goods). Marketable nanofiltration membranes maintain a fixed charge created by the dissociation of face groups, similar to sulfonated or carboxylic acids. As a result, the parcels of NF membranes enable the separation of ions using a mixture of the size and electrical goods of UF and the ion commerce processes of RO. The NF membrane is a fairly recently introduced technology in wastewater treatment systems. The size of pores in NF membranes (slightly 1 nm) is analogous to the fact that indeed small uncharged solutes are largely rejected while the face electrostatic parcels allow monovalent ions to be nicely well transmitted with multivalent ions mainly retained. These characteristics make NF membranes extremely useful in the separation and selective dumping of solutes from complex process streams. The development of NF technology as a doable process over recent times has led to a remarkable increase in its operation in a number of industrial analogous applications, such as the treatment of pulp-dulling backwoods from the cloth sedulity, the separation of chemicals from fermentation broths, demineralization in the dairy sedulity, substance recovery from wastewater, and contagion mixtures of waste [37].

3.3.8. Microorganisms

Microorganisms are the main sources that can be used to detoxify chemical substances. Bacteria are dangerous to humans and the environment, but some are beneficial. Fungi and algae are microbes, especially microalgae. They can be used to remove pollutants from different environments. It is called phytoremediation. Chlorella vulgaris are eukaryotic, unicellular, and photosynthetic microorganisms that are naturally abundant in aquatic systems such as marine and freshwater. C. vulgaris is of great concern for the removal of secondary pollutants like ammonia from wastewater, and this organism can be used as a bioremediation agent in various types of wastewater [38]. There are different groups of bacteria, like Pseudomonas fluorescens and Pseudomonas putida, and different Bacillus strains that are suitable for use in natural wastewater systems. These bacteria work in cluster form as a floc, biofilm, or scrap during wastewater treatment. Likewise, after the recognition of bacterial exopolysaccharides (EPS) as an effective adsorption material, it may be applied in a revolutionary manner for heavy substance elimination. There are numerous samples of EPS that are commercially available, i.e., alginate (P. aeruginosa, Azotobacter vinelandii), gellan (Sphingomonas paucimobilis), hyaluronan (P. aeruginosa, Pasteurella multocida, and Streptococci downgraded strains), xanthan (Xanthomonas campestris), and galactopol (P. also (2014) experimented with the biodegradation of external wastewater using original and marketable bacteria (Sludge Hammer), where they achieved a significant drop in synthetic wastewater (i. aer) and aer Therefore, predicated on the below studies, it can be concluded that bioaugmentation of wastewater treatment reactors with picky and mixed strains can ameliorate the treatment. In recent times, microalgae have attracted the attention of researchers as a necessary system due to their connection to wastewater treatment. Algae are unicellular or multicellular photosynthetic microorganisms that grow on water shells, tar water, or damp soil. They use an excessive amount of nutrients like nitrogen, phosphorus, and carbon for their growth and metabolism processes in their anaerobic system. This property of algae also inhibits eutrophication, that is, the over-deposition of nutrients in bodies of water. During the nutrient digestion process, algae produce oxygen that is constructive for the heterotrophic aerobic bacteria, which may be further employed to degrade the organic and inorganic adulterants. total drop in the levels of COD, total nitrogen, and total phosphorus after using algae in the external wastewater institute. The report shows the heavy-substance junking effectiveness of microalga Scenedesmus sp. from defiled sluice water in the Melaka River, Malaysia. They observed the effective dumping of Zn on the 3rd and 7th days of the trial [4].

3.3.9. Applications of Wastewater Management

- Applications of wastewater treatment can be found in various fields, such as irrigation (for irrigation of parks), car washing, fire protection systems, and cleaning. For agricultural purposes, these are used in seed crops, irrigation of agricultural land, and

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dust control. As for environmental uses, it can be used in silviculture and wildlife habitat [10].

- Applications of grafted flocculants of aluminium chloride and polycarboxymethyl starch can be performed in municipal sewage wastewater [39]. The cultivation of spirulina in wastewater treatment can be used in the production of bioactive additives (for example, insulin resistance in horses) and can be used in the production of dairy products [40].
- In the scope of crop irrigation, the secondary treatment of wastewater can be used in soil fertility and chemical characteristics for tomatoes and broccoli can be cultivated in groundwater, secondary treatment, and tertiary treatment from agro-industrial waste. It can be used in the production of energy resources and also in the production of natural fertilisers by composting or vermicomposting solid sludge from industrial waste [4].
- The growth and development of biomass in wastewater can be used in the production of animal feedstock, ingredients for the cosmetic industry, and bulk chemicals such as microalgal carbohydrates, which are converted into lactic acid by the metabolic activity in the wastewater [41]. The production of lipids, glycolipids, and enzymes by yeast microbial activity is involved in the various treatments of high organic wastewater, heavy metal ion waste, domestic sewage, and municipal wastewater treatment [42].

3.3.10. Advantages and Disadvantages of Wastewater Treatment

3.3.10.1. Advantage

The use of chemical precipitation is a simple technical method and a highly efficient and integrated physicochemical process to clean up high loads [34]. Nanofiltration can be used in small spaces and is highly efficient at low concentrations; it is a rapid method, and chemicals are not required to initiate the process [9]. The flotation process can be used for the highly selective treatment of toxic metals and the elimination of highly volatile compounds at a high removal rate [25]. The ion exchange treatment in wastewater is simple, easy to control, and requires little maintenance. This process is rapid and highly efficient in wastewater treatment [34]. The enzymatic decomposition of wastewater is performed by biological cultures, which achieve high BOD and BAS removal rates. This treatment can remove emergent contaminants using decisive microbiological techniques [9].

3.3.10.2. Disadvantage

The chemical precipitation process requires an oxidation process to complete the metal, and it produces high sludge, which leads to contamination and chemical consumption [34]. The operation of the Nanofiltration process is high cost and maintenance and the design for large scale differs significantly [9]. Flotation processes need extra cost for sludge removal treatment, and this process can lead to contamination of the environment and pollution, and the recovery rate is very low when compared to other processes [25]. One of the disadvantages is that the ion exchange process requires a large volume, is sensitive to pH, and is economically constrained [34]. Enzymatic decomposition processes using biological culture are very slow, have poor decolourization, and involve complex mechanisms [9].

4. Conclusion

Waste management is necessary for the control of toxic substances, pollutants, and other chemical contaminants in water, which affect the environment and human health. The treatment of waste in water can improve the reuse of treated water in various applications and increase the recycling ability of water for human and natural purposes. This treatment can be led by four different processes for urban, municipal, and industrial waste effluent, and other physical, chemical, and biological methods can be performed to treat the waste. Many countries are following sewage water treatment technology, such as India, where many states can use this waste treatment technology to reduce waste and maintain sustainable sources of water to flow the water cycle for future consumption. Pollution from man-made waste can be controlled by the 3R technology scheme. The treated waste from the water can be applied in many applications, such as in the agriculture field, urban areas, and for environmental purposes. Therefore, the waste extracted from the water can be recovered and disposed of safely in the environment.

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