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Treatment and reclamation of wastewater

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ABSTRACT

Water is an indispensable resource and crucial to sustaining life. Water scarcity is one of the largest threats all over the world. The growing population, rapid industrialization as well urbanization discharges wastewater. The wastewater presents various pollutants like biological agents, heavy metals, dyes, phenols, pesticides as well as dissolved or non-dissolved chemicals. Wastewater treatment is one of the most important solutions to reuse the water. The wastewater consists of physical, chemical, and biological characteristics. Several parameters are involved to check water quality. The three distinct types of water quality parameters like physical, chemical as well as biological parameters. Several physicochemical methods and technologies are recently used in wastewater treatment. The treatment of wastewater protects human health and reduces the amount of waste that is generally released into the environment and improves environmental health. Wastewater is one of the most essential reliable sources of irrigation water for several farmers. The most general sources of marginal quality water are Agricultural drainage water, Municipal and Industrial wastewater as well as shallow groundwater. Wastewater reclamation and reuse are imperative for the future. The important role of wastewater reclamation is saving the sustainable environment. The reclaimed water is used for various purposes like irrigation, gardening, cooling system, toilet flushing, cooling of air conditioning system, and several other uses.

Keywords: *Wastewater, Water Treatment, Reclamation of Water*

1. INTRODUCTION

Water is an essential resource and crucial element for sustaining life and human activities [1]. All living things present on the earth required water for their existence as well as development. Around 70% of the earth's surface is covered in water. The several pollutants present in the water are influencing the quality of water and affecting human health [2]. There are three types of water quality parameters physical, chemical, and biological. Physical parameters consist of pH, odour, temperature, taste, salinity, turbidity, hardness, conductivity (C), total dissolved solids (TDS), and total suspended solids (TSS). Chemical parameters of water consist of metal irons, fluorides, organics, nutrients, pesticides, dissolved oxygen (DO), biological oxygen demand (BOD), chemical oxygen demand (COD). Biological parameters consist of bacteria, viruses, protozoa, and helminths [3]. Wastewater is the poor quality of water that is negatively influenced by human-induced activities [4]. The wastewater can be described based on physical, chemical as well as biological characteristics [5]. But because of the growing human population, usage of fertilizers in the field of agriculture, industrial development in addition to other human activities, the surface water is greatly contaminated with various dangerous pollutants [6]. The various contaminants are man-made like industrial and agricultural waste consist of heavy metals including mercury, chromium, copper, lead, and harmful chemicals, dyes, as well as compounds such as insecticides and fertilizers. The microbial contaminants consist of pathogens such as bacteria, viruses, and parasites [7]. The appropriate treatment of wastewater before its discharge is essential for safe the environment [8]. Wastewater treatment is a procedure in which pollutants are segregated from the liquid state through the way of several physical and chemical processes, before its environmental discharge of the water. The preliminary

treatment is the elimination of large materials including heavy detritus from the sewage. This step generally consists of screening as well as grit removal. The primary treatment includes separating the large part of the suspended matter from the wastewater with the help of the sedimentation process. The removal of organic matter including remaining suspended particles, the waste proceeds further, during secondary treatment, in which biological processes that are decreased the BOD level and major number of organic matters, in addition to a small number of suspended particles [9]. Tertiary treatment or advanced wastewater treatment process is used to improve the quality of effluent that is resulted from primary as well as secondary treatment. The reason for water scarcity, water from wastewater treatment is one of the most important necessities in the future [10]. The crucial role of wastewater reclamation is saving the sustainable environment. Wastewater treatment is crucial for all across the world. Reclaimed wastewater is generally used in agriculture irrigation [11]. Many farmers irrigated with the help of marginal-quality water. Wastewater is one of the most reliable or inexpensive sources of irrigation water for numerous farmers. The use of treated wastewater in the agriculture field gives several benefits that provide crucial nutrients for crops growth [12]. The wastewater uses are recharge of aquifers, industrial applications, seawater barriers, toilet flushing as well as other urban uses [13].

2. WASTEWATER CHARACTERISTICS

The nature of wastewater consists of physical, chemical as well as biological characteristics.

Physical characteristics: The physical properties of wastewater consist of color, odor, turbidity as well as temperature. The fresh sewage water is eventually lightweight including brownish-grey in color. Although, the other sewage water is grey in addition to consisting of cloudy appearance. The typical septic sewage water shows black colour. The fresh domestic wastewater characteristic is the musty odour. Whether wastewater is permitted to move septic, the odour perhaps greatly altered like rotten egg odour related to the formation of hydrogen sulphide. Turbidity measurements are useful for water quality analysis. Turbidity measures the light-transmitting properties of water; this test is used to denote the quality of waste discharges as well as natural waters regarding colloidal including residual suspended matter. The temperature of wastewater is generally excessive because of the inclusion of warm water from households as well as industrial activities.

Chemical characteristics: The chemical properties of wastewater mostly consist of pH as well as oxygen demand. The analysis of hydrogen ion concentration in wastewater is a crucial process. Wastewater presents a distinct chemical in several forms like Chemical Oxygen Demand (COD), Total Organic Carbon (TOC), Nitrogen, Phosphorus. In chemical oxygen demand (COD) is a measure of organic materials in wastewater in terms of the oxygen is necessary because that is too oxidized the organic materials. The Total Organic Carbon (TOC) is a measure of carbon in organic materials. Nitrogen is measured in various forms like nitrite, nitrate, ammonia as well as organic nitrogen (that is the amount of nitrogen present in organic compounds). Phosphorus is generally measured in its mineral and organic forms, total phosphorus, chlorides, sulphates, heavy metals. Alkalinity in wastewater results from the presence of hydroxides, carbonates as well as bicarbonates of elements like calcium, magnesium. The alkalinity in wastewater is useful to resist the changes in pH caused by the addition of acids.

Biological characteristics: The biological characteristics of wastewater consist of bacteria as well as other living microorganisms likewise protozoa, algae including fungi. Wastewater treatment is a process in which protects the environment and safety of health. Numerous opportunistic pathogens (e.g., Enterococcus faecalis, Escherichia coli, Enterobacter cloacae, Klebsiella pneumonia, Proteus Vulgaris, or Pseudomonas aeruginosa) can be transferred by wastewater, that may cause several systemic infections, mainly in persons that have a weak immune system. The compulsory pathogens of the salmonella as well as shigella genera or enteropathogenic strains of Escherichia coli, which are responsible for salmonellosis, shigellosis, or gastroenteritis, are also present in the wastewater. The sewage system in which 18 species of the genus Georgia, Thauera, Longilinea, Desulforhabdus, Arcobacter as well as Desulfuromonas are noted. Clostridium, Methanosarcina as well as Methanosaeta are included in the bacterial genera that take part in the process of anaerobic methane fermentation. The treated effluent presents fecal bacteria of the genera Bacteroides and Bifidobacterium, in addition to Clostridium perfringens [14].

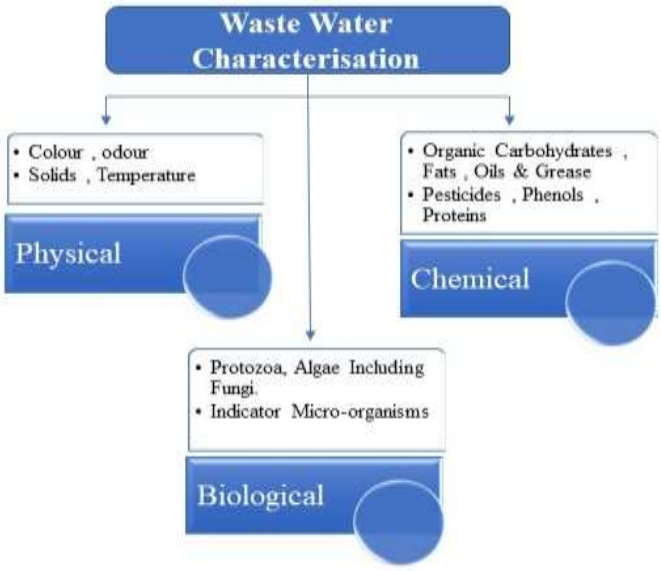

Fig.1. Waste Water Characteristics

3. WATER QUALITY PARAMETERS

Water is the most vital natural resource for all life on earth [15]. The accessibility of quality of water plays an essential role in determining not only humans can live but also the quality of life [16]. These days because of a growing population, industrial development, agricultural activities as well as urbanization, a huge amount of sewage including industrial wastewater is released into the water bodies that are mainly involved in the pollution of water. Therefore, the estimation of water pollution condition of water bodies, the different water quality parameters are determined [17]. The water quality parameters are divided into three types like physical, chemical as well as biological parameters. Physical parameters consist of temperature, taste, pH, odor, color, hardness, salinity, total suspended solids (TSS), turbidity, total dissolved solids (TDS) including conductivity. The chemical parameters consist of pesticides, metal irons, alkalinity, fluorides, biological oxygen demand (BOD), dissolved oxygen (DO), and chemical oxygen demand (COD). Biological parameters consist of bacteria, viruses, protozoa, and helminths [18].

Temperature: Temperature plays an important role in regulating aquatic communities. Whether the entire water body temperature of the system is changed, in that case, aquatic

community alterations can be predicted. The water greater than 30°C, repression of all benthic organisms may be privileged predicted. In addition to other distinct planktons, groups are developed under distinct temperatures. e.g., diatoms dominated at 20-25°C, green algae at 30-35°C, and cyanobacteria dominated at greater than 35°C [19].

pH: pH is an essential parameter of water quality. pH is the negative logarithm hydrogen ion concentration. pH is the indicator of the presence of living things as many of them develop in a slightly narrow as well as critical pH range. pH is crucial for detecting the corrosive character of water. Decreased the pH value greater the corrosive character of water. pH is certainly related to the electrical conductivity as well as total alkalinity. The decreased rate of photosynthetic activity the occurrence of carbon dioxide as well as bicarbonates that are eventually taking part in an increase in the pH. The several components caused changes in the pH of water. The greater pH values noted to indicate that carbon dioxide, carbonate-bicarbonate equilibrium is afflicted majorly because of change in physical, chemical condition [20].

Dissolved Oxygen: Dissolved oxygen (DO) is the essential parameter. Dissolved oxygen (DO) is crucial for aquatic life. Its connectivity to the water body provides direct as well as indirect information e.g., bacterial activity, the accessibility of nutrients, photosynthesis, stratification. Dissolved oxygen occurs in the dissolved gaseous form of oxygen. It is crucial for the respiration of fish as well as aquatic organisms.

Colour: Color is crucial for many water users, to that domestic as well as industrial, generally select colorless water. The inorganic matter like rocks, soil, as well as stones that are influenced the color of the water. Pure water is colorless so that any type of color appeared in water that denotes water pollution.

Conductivity: Conductivity is used to denote the presence of ions in the water. Conductivity exhibits an important association to the ten parameters like temperature, alkalinity, calcium, pH value, total dissolved solids, total hardness, total solids, chemical oxygen demand, chloride as well as the iron concentration of water. Conductivity is the ability to convey an electric current. The solutions of many like inorganic acids, bases as well as salts are nearly good conductors [21].

Turbidity: Turbidity can be occurred because of organic as well as inorganic components. Organic particles can harbour microorganisms. Therefore, in the turbid state that can enhance the chances of waterborne disease. The sequence of turbid-produced changes that take place in the water body can alter the arrangement of the aquatic community. First, turbidity because of a greater number of suspended sediments decreases the light entry, therefore reducing the photosynthetic activity of algae, phytoplankton as well as macrophytes, particularly those far from the surface. Whether turbidity is high because of algae, light is not entered very far in the water, and primary production is limited in the topmost surface of the water.

Total Suspended Solids: Total suspended solids are the sign of erosion that occurred close by or upstream. The settled suspended solids from the turbid waters threaten the benthic aquatic life. Settled components can obscure sources of hiding sites, food, habitat, as well as nesting places.

TDS: The total dissolved solids (TDS) in the water include inorganic salts as well as a small number of organic substances in the water [22]. In natural waters, salts are chemical compounds that consist of anions like carbonates, sulfates, chlorides as well as nitrates (mainly in groundwater), and cations like magnesium (Mg), sodium (Na), potassium (K) as well as calcium (ca).

BOD: Biological oxygen demand is a measure of organic pollution in waste as well as surface water. The greater the BOD is the sign of low water quality. Bacteria as well as other microbes utilize organic material for food. They are metabolized organic substances, that are consumed oxygen. The organics are breakdown converted into simple compounds like CO_2 and H_2O, and the microorganisms utilized the energy released for growth as well as reproduction. The higher the organic substances in the water, the greater the BOD utilized by microorganisms. The BOD is used to measure the ability of sewage; powerful sewage has greater BOD and weak sewage has less BOD.

COD: Chemical Oxygen Demand is the sign of organics in water, generally used in associated to the BOD. Greater organic insert activate deoxygenation. Whether high organics are inserted in the system, there is the capability for total consumption of dissolved oxygen. In the absence of oxygen, the whole aquatic community is threatened. The only air-breathing insects, as well as anaerobic bacteria, are occurred. Whether total oxygen is reduced, aerobic breakdown ceases and another organic breakdown can anaerobically. Anaerobic microorganisms acquire energy from oxygen bound to other molecules like sulfate compounds. The chemical oxygen demand is the parameter that is measured by all organics: the biodegradable as well as non-biodegradable components [23].

4.CATALOGUING OF THE CONTAMINANTS

Wastewater is a mixture of liquid as well as water-transferred waste discharge from the residences, mechanical, business, or farming activities along with surface overflow and stormwater. It commonly includes a greater amount of oxygen demanding wastes, pathogenic or infectious agents that cause diseases, organic substances, nutrients that induced plant development, inorganic chemicals and minerals as well as sediments [24]. Pollutants are the contaminants that are added to the environment that has undesired effects or damage the resources. The pollutants are occurred in several types [25]. The pollutants occurred in various types like biological agents, heat, heavy metals, dissolved and non-dissolved chemicals, dyes, phenols, and other miscellaneous substances [26]. several biological agents like Escherichia coli, Salmonella typhosa, Shigella dysenteriae, Vibrio comma as well as Yersinia enterocolitica, can be occurred in domestic waste and sewage water and they are required to be eliminated. The other major waterborne diseases like typhoid, gastroenteritis, cholera, dysentery including jaundice they are caused due to biological agents [26,27]. The other industries released hot water into the water bodies they mainly affect the aquatic life as caused by thermal pollution [28]. The chemical that occurred in wastewater can be a dissolved and non-dissolved form. Non-dissolved materials commonly occur as suspended solids in the distributed state. The more general chemical occurred in the wastewater in a dissolved form and was regarded as potential pollutants like dyes, detergents, heavy metals, pesticides, phenols, Polychlorinated biphenyls (PCBs), and another inorganic as well as organic materials [26,29]. The wastewater is produced from numerous industries that can present several heavy metals

that are causing harmful effects [26,30]. The wastewater includes heavy metals like cadmium, chromium, iron, lead, arsenic, manganese, copper, mercury, vanadium, cobalt, nickel, as well as bismuth [26,31]. Dyes are used in domestic as well as industrial uses. The main user of dyes is dying, tannery, paper, and pulp, textile as well as paint industries. Therefore, the waste from the industries along with those from plants producing dyes that carry dyes in enough amount for them regarded as an objectionable kind of pollutant due to they convey color to the water, that are not suitable on aesthetic grounds, and that is harmful as well as negative effects on life. Phenols are the most important concern pollutants like they convey unpleasant taste as well as odor to the water. Phenols that occurred in the was water are produced from paint, paper, and pulp, pesticides, chemical as well as dyeing industries [26,32]. The other miscellaneous substances are produced from various industries. The radioactive substances are present in the wastes that are arising from the nuclear power plants, research laboratories, ore processed laboratories as well as hospitals. Detergents are synthetic as well as natural detergents are commonly used for emulsification including the cleaning process. The domestic wastewater, waste of pharmaceuticals as well as other industries can include them [26,33]. Polychlorinated biphenyls (PCBs) are produced in some manufacturing activity, that consist of the make of brake linings, grinding wheels, flameproof paints, glass ceramics, varnishes, several kinds of coatings, sealants, electrical material as well as plastic coatings. While several pollutants are mainly crucial for urban places, pesticides are the major difficulty originating from rural activities. The issue of pesticides pollution is derived from agricultural actions as well as pesticides producing plants [26,34]. The other organic chemicals are found in wastes produced from several industries. These consist trihalomethanes, like chloroform as well as bromoform; trichloroethylene; tetrachloroethylene; aromatic hydrocarbons, like xylene, benzene, toluene including biphenyls; halogenated aromatics, like chlorobenzene, dichlorobenzene, chloroxylenol as well as chlorotoluene; halogenated aliphatic compounds, consist dibromomethane, bromochloromethane, and tetrachloromethane; halogenated ethers; polycyclic aromatic hydrocarbons, like fluorene, naphthalene, acenaphthalene, and phenanthrene; aldehydes; esters; alicyclic hydrocarbons; and ketones [26,35].

5. WASTEWATER TREATMENT TECHNOLOGIES

Water is the most vital natural resource for life [36]. The provision of clean water is a crucial need for the development as well as various human activities [37]. The growing world's population, rapid industrialization, as well as other activities, increase the water demand [38]. Wastewater presents organic particles, a large quantity of pathogenic or disease-causing microorganisms including other toxic components. So, the treatment of wastewater is necessary before entering the natural water bodies [39]. The wastewater treatment process decreased the quantity of waste that is released into the environment and help in improving environmental health [40]. The wastewater treatment is divided into physical, chemical as well as biological methods that are used to remove pollutants from wastewater. The physical methods in which the physical pressure is enforced to eliminate the pollutants. The physical wastewater treatment consists of flow equalization, sedimentation in addition to flotation. The flow equalization is used to enhance the efficacy of secondary as well as fundamental wastewater treatment processes by leveling out action parameters like flow, pollutant quantity including temperature throughout the period. The sedimentation is a basic and commonly used unit functioning in wastewater treatment, including the gravitational setup of heavy materials suspended in a combination. The flotation method is in which air bubbles are inserted to remove solid or liquid particles from the liquid [41]. The chemical method consists of some operations like disinfection, chlorination, chemical precipitation as well as adsorption. Disinfection is the process in which eliminates or kills microorganisms. Chlorination is the process of removing chlorine from the water before discharging the water into the environment. chlorination is typically accomplished by the use of activated carbon as well as adding reducing agents like sulfur dioxide, sodium sulfite, or sodium metabisulfite. Chemical precipitation in which precipitation of heavy metals is occurred by reaction with various of chemicals than the formation of insoluble precipitates. The final precipitates can be eliminated from the water with the help of sedimentation as well as filtration. Then treated water is drained and properly released or reused. In between the chemical coagulants that are generally used in wastewater treatment: ferric sulfate, alum, ferrous sulfate, ferric chloride as well as lime. Then adsorption process in which assembling soluble materials in the solution on an appropriate surface. In wastewater treatment, adsorption along with activated carbon a solid interface normally follows typical biological treatment and is focused on eliminating a part of the other dissolved organic particle. The Biological method in which consist of an activated sludge process as well as trickling filters [42]. The biological unit processes are used to change the separate and dissolved organic particles in wastewater in the flocculent organic as well as inorganic solids. This process in which microorganisms, especially bacteria, adjust the colloidal including dissolved carbonaceous organic particles in the combination of gases and that is eliminated in sedimentation tanks. The activated sludge process in which large quantity of microorganisms such as bacteria, fungi, and protozoa and present like an unbound clattered mass of thin particles that are maintained in deferment by stirring, along to remove organic particles from the wastewater. Then trickling filters is the development process in which microorganisms charge of treatment are associated with the dormant pressing substances. Trickling filters are accomplished in that waste eminence such as suspended solids as well BOD removal is excellent [43]. The wastewater treatment consists of preliminary, primary, secondary, tertiary, or advanced wastewater treatment [41,44]. The purpose of preliminary treatment is the elimination of coarse solids as well as another large particle that occurred in the raw wastewater. The preliminary treatment is useful to eliminate or to decrease in size the large, suspended, or floating solids. This solid involved plastics, fragments of wood, paper, cloth, waste in addition to fecal matter. Eliminate the heavy inorganic solids like gravel and sand furthermore glass or metal. These things are known as grit as well as an enormous quantity of oils or greases. The primary treatment is described to eliminate organic as well as inorganic solids with the help of physical processes of sedimentation including flotation. Around 25-50% of the arriving biochemical oxygen demand, 50-70% of total suspended solids, as well as 65% of the oil including grease, are eliminated in the primary treatment. Few organic phosphorus, organic nitrogen, in addition to heavy metals linked to solids as well eliminated in the course of primary sedimentation, although colloidal including dissolved components are not afflicted. The aim of secondary treatment is another treatment of the sewage from primary treatment to eliminate the remaining organics as well as suspended solids [45]. The secondary treatment process involved the biological treatment

of wastewater in which use of several distinct kinds of microorganisms under a managed environment. Various aerobic biological processes are applied for secondary treatment vary mainly in the way oxygen is provided to the microorganisms and in the amount that organisms metabolize the organic particle [45,46]. Tertiary or Advanced treatment involved the processes that are described to attain greater effluent quality than obtained by the secondary treatment. Which consists of polishing stages like ion reverse osmosis, electrodialysis, chemical oxidation, and nutrient elimination [47]. The Reverse Osmosis (RO) process uses a semi-permeable membrane that can remove Organic particles, suspended solids, color, nitrate as well as bacteria from water. This process is also used for the treatment of municipal wastewater [48]. Electrodialysis (ED) is another membrane separation process that is applied in wastewater treatment. The ion exchange membrane is applied between anode and cathode in the ED system [49]. The membranes are essential of two main types such as cation-exchange and anion-exchange membranes. This process is mainly used for the production of drinking and process water from brackish water and seawater. This technique is also used for the food processing, pharmaceutical industries, including wastewater treatment, recovery of useful materials as well as the elimination of harmful components [50].

6. RECLAMATION OF WASTEWATER

Water is the most essential resource. The wastewater reclamation and reuse technologies are crucially obtained from them utilizing the water and wastewater treatment. Reclaimed water has economic importance this is another source of water supply [51]. Wastewater reuse is extensively used as an essential source of water provide in water-lacking countries. The wastewater reuse gives rise to sustainable development they are used in reducing the water demand as well as total sewage formation [52]. Millions of smallholder farmers across the world irrigated with the help of marginal quality water. In which two main kinds of marginal quality water: wastewater from urban as well as peri-urban regions, and saline and sodic agricultural drainage water in addition to groundwater. The utilization of wastewater by smallholder farmers that are produced fresh vegetables including other crops in urban as well as peri-urban regions. The use of wastewater helps to produce fodder, grains, in addition to industrial crops. The treated wastewater is widely used in environmental applications (riparian habitats, wetlands, wildlife refuges, urban lakes including ponds), industrial purposes like boiling, cooling as well as processing) [53]. The treated wastewater is used for nonpotable purposes including dust control, firefighting, air conditioning, groundwater recharge, vehicle washing as well as building construction activities [53,54]. Water reuse can be regarded as the major component of environmental pollution control as well as water management planning [55]. Treated wastewater is used in agriculture that is helpful for the environment, public health, and economic development [56]. Wastewater is one of the most reliable or inexpensive sources of irrigation water for numerous farmers. The value of irrigation for agricultural production is increased tremendously [57]. The various crucial advantage of wastewater irrigation is recognized involved plant nutrient recycling as well as enhanced agricultural productivity. Water reuse has several essential and varied roles [58]. The water is reused for agricultural as well as landscape irrigation it consists of agricultural, residential, municipal as well as commercial purposes. Industrial reuse is a common class including water use for various industries it involved power plants, food processing, and certain industries with a greater level of water use [59]. Household wastewater is also reused for several purposes like car washing, landscape irrigation, floor washing as well as toilet flushing [60].

7. CONCLUSION

Ecosystems are categorized into terrestrial and aquatic ecosystems. Water-dependent creatures, plants, and microorganisms call the aquatic ecosystem home. The oceans contain approximately 97 percent of the water on the earth's surface. Along with this, all the living and non-living inhabitants are dependent on the 3 percent aquatic ecosystem. So, water plays a key role in maintaining sustainability in the environment. But water ecology is disturbed by human or natural contaminants. Wastewater treatment and reclamation of wastewater is the process of restoring a desirable quality to water. For the treatment of wastewater combination of the process used viz. Physical, Biological, and chemical. some advanced technologies are also used to treat wastewater. Wastewater treatment Is the management of a sustainable environment. Wastewater must be treated properly to avoid water-borne, vector-borne diseases caused by the deadliest pathogen or micro-organism. water reclamation or water reuse is the new trend for the sustainability of the growing population. wastewater is treated in such a way that harmful effects are minimized like all biodegradable materials, contaminants, and pathogens are removed and viable for the surrounding environment, which is nothing but the reclamation of water. Reclaimed wastewater is useful for industrial, agricultural, groundwater recreation. water reuse or reclamation of the wastewater is an expensive process initially but growing populations along with the water stress that demand for the water reuse or Reclamation of wastewater.

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