Chapter 9
Green Technologies for Wastewater Treatment

T. Vasantha and N. V. V. Jyothi

Contents

T. Vasantha (✉) · N. V. V. Jyothi
Department of Chemistry, Sri Venkateswara University, Tirupati, Andhra Pradesh, India

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Abstract A metals accretion of solids, liquids, and gaseous toxic waste has upshot from a lack of improvement in toxic waste management. This has necessitated the design of an assortment of novel research works in water and wastewater treatment, industrialized dissipate management, ground water, and soil pollution subsistence. Simultaneously, increasing concerns about water sources are becoming a considerable matter, as a paucity of water has been seen all over the earth. A number of expanding technologies have the know-how to modernize our world of commercialization. Advanced Treatment Techniques for Industrial Wastewater is an innovative collection of research that covers the different aspects of environmental engineering in running water and wastewater treatment processes with the different techniques and systems for pollution management. A number of them are presently within the scope of improvement but there is lingering frustration to firmly implement them in civilization, and all are propitious solutions to some very authentic challenges facing the planet. The term "Green Technology" is relatively new and has been slowly adopted over the most recent decades; emerald is the present day system for a healthy life. This chapter illustrates different green technology challenges and their chance to enhance wastewater treatment technologies and trends toward progress.

Keywords Jade (Green) chemistry · Green technology · Wastewater treatment · Advantages and disadvantages of green technologies

9.1 Introduction

Water is one of the most precious resources on earth. All living organisms require water for survival. Without the presence of water, life would not exist on the globe. Water covers nearly 71% of the Earth's surface, but only 2.5% of it exists as freshwater. A huge volume of wastewater is released from the areas of urbanization and industrialization, and it was utilized more by irrigation resources in semi-urban and urban agriculture areas (Shahat et al. 2015). Economic activities drive countless lives, including for poor farmers, and this has dramatically changed the quality of water bodies (Marshall et al. 2007). Current awareness on the contaminant risk posed to natural water bodies has to expand so that efficient studies toward improved industrial development can be assessed. Because of increased industrial wastewater, the massive features of contaminants in organic and inorganic complex mixtures have increased, so there is a need to treat the concentration of pollutants in the wastewater and the environment by using a treatment process (Woisetschlager et al. 2013; Sires et al. 2014). It has become a crucial necessity for today's atmosphere to stop water from becoming polluted or expand the cost effectual curative scheme used for its defense (Awual et al. 2015). Owing to the hasty growth of the inhabitants in emerging countries, the offered predictable treatment for wastewater plants are being overloaded, and there will be no space obtainable for growth of the existing treatment plants. Reprocessing and reuse of air, water soil pollutants, and waste have been emerging topics throughout the 2010s, to shield innate resources and the atmosphere (Corder et al. 2015; Colling et al. 2016).

One of the foremost sources of wastewater is farming effluent that contains pollutants and contaminants, including chemicals, microorganisms, nutrients and other toxin, municipal runoff, and squall water. Sewage as wastewater includes water from cleaners, bathing, laundry, toilets, bathroom fittings, and sinks. Influent is the wastewater that flows into a treatment plant, reservoir, or basin. As this wastewater is inappropriately released into the river bodies, these pollutants can cause an ecological issue leading to health tribulations in humans and animals (Wongburi and Park 2018; Jhansi and Mishra 2013). Yet, wastewater also contains reusable wherewithal, such as carbon, nutrients, and water, that could be recovered or reused. For that reason, wastewater ought to be fittingly treated for elimination of pollutants to meet the effluent regulatory values. Moreover, the process should focus on resource recovery to lessen the carbon footprint and to be self-sustainable (Metcalf and Eddy 1991).

Some form of wastewater treatment has been used since antiquity; however, a variety of conventional methods used to treat the water have not been economical (Pawar Avinash Shivajirao 2012). Therefore, innovative green technology methods are being introduced to defeat the predictable methods of wastewater treatment (Zhou and Smith 2002; Turovskiy 2014).

Currently, the management of waste and superiority of water are significant concerns for human life. The accretion of technology in urbanization and industrialization explains the increase in the percentage accumulation of waste all around the world and the discharge of heavy metals in water streams. The release of inadequately treated industrial waste containing heavy metals affects waterways and turns into a stern ecological problem in need of solution development (New Technologies in Wastewater Treatment 2014). The use of heavy metal polluted wastewater to irrigate poses a risk to civic health (Siddique et al. 2014). These destructive metals are produced from a variety of activities, such as waste disposal, industrial, agricultural, and others. Increasing the heavy metals content in wastewater streams has negative effects on human bodies, including death. Technology used in the handling of wastewater includes chemical precipitation, absorption, ion-exchange, coagulation flocculation, and membrane filtration; flotation and electrochemical and the added advanced oxidation process involve enormous outfitting and regulation overheads (Nabi et al. 2011; Gutha et al. 2015; Cheng et al. 2012; Javadian et al. 2014). Consequently, an outlay of effectual green skill toward the removal of these heavy metals as well as progress in the effluent standards is desired.

Energetic industrialization has resulted in a huge extent of wastewater from industrial zones, for instance paper, crop fruit, sugar, pulp, distilleries, cuisine processing, slaughterhouses, sago/starch, poultry farms, tanneries, dairies, etc. Regardless of the requirements for toxic waste manage events, this wastewater is usually dumped on territory or used to irrigate, devoid of enough treatment, and it consequently becomes a gigantic resource of ecological toxic waste and physical condition hazards. The wastewater organization in India has grown to be an extremely necessary regional hub owing to escalating health concerns and inhabitant's pressure. In spite of the wastewater sector witnessing major augmentation in the past decade due to escalating government support and private involvement, the scale of the problem remains vast. It is estimated that less than 20% of domestic and 60% of industrial wastewater is treated. Metros and big cities (more than 100,000 inhabitants) treat merely about 29.2% of their wastewater, whereas smaller cities treat only 3.7% of their wastewater. Manufacturing wastewater includes industrial effluents (with or without pre-treatment) and sometimes also cooling water from energy construction and mining water. The trivial enrichment in wastewater quantity is chiefly based on reduction in the production process and sometimes because of upgrading or edifice of effective treatment conveniences (Martin-Lara et al. 2014).

Within the present developing world, the term green technology has played a considerable function during the course of a nation's fiscal growth toward sustainability and provided an alternative socioeconomic model that will enable the current and upcoming generations to live in a hygienic as well as hale and hearty atmosphere, in accord with nature. Clean technology, furthermore identified as green technology, refers to the development and extension of the processes, practices, and applications to improve or replace the existing technology and facilitate society to meet their own requirements and at the same time substantially decrease the impact of humans on the globe amid ecological risks and environmental scarcity. The theory of green technology, if allowed to pervade the lives of all societies, will ease the aim of the millennium improvement goals of keeping the environment intact and developing it for the long-term survival of civilization. Green Technologies and Environmental Sustainability are focused toward the goals of green technologies, which progressively give more importance to ensuring sustainability. This chapter shows altered perspectives of green technology in different zones, including energy, agriculture, waste management, and economics and contains current advancements ready for sustainable increases in the field of bio energy, green chemistry, nanotechnology, degraded land reclamation, and bioremediation.

Additionally, advanced manufacturing industries along with the emergent are allied by the superior treatment process, resulting in considerable development toward the versatility and the outlay of this process at the industrialized scale. By means of lifecycle investigation, for instance, (Wiesner et al. 1994) concluded that the outlay of new pressure-driven membrane filtration plants are predicted to be analogous with or smooth less than that of folks by means of a predictable treatment process with a capacity of 20,000 m^3/day.

To resolve the innovative challenge as well as enhance inexpensive wherewithal, a variety of advanced treatment technologies can be wished-for, tested, and applied to gather both modern and expected treatment needs. Amid them, membrane filtration, UV radiation, and advanced oxidation processes have been traditional for victorious deletion of an extensive range of taxing contaminants in irrigation and treatment of wastewater. This chapter focuses on the superior treatment of green technologies with an emphasis on their main applications, fundamentals, advantages, and disadvantages. The recent boundaries and future research desires related to this technology are discussed in this chapter (Fig. 9.1).

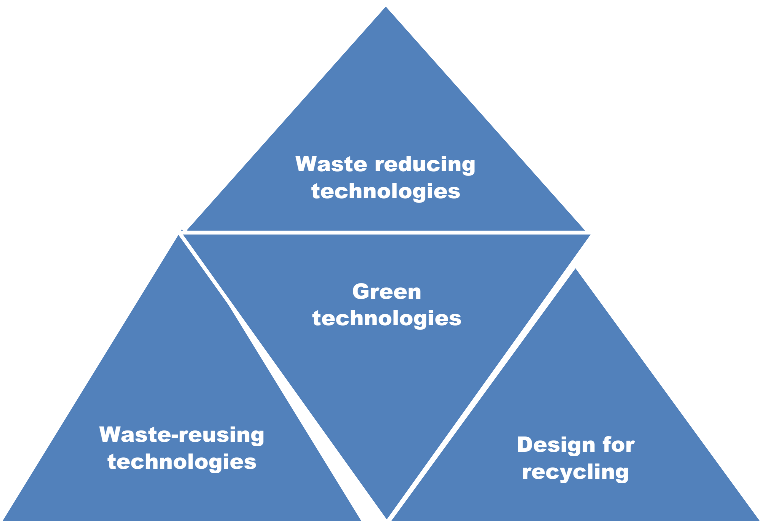

Fig. 9.1 Designing of green technologies

9.1.1 Characteristics and Treatment Technology of Wastewater

The features of wastewater containing heavy metals, such as the treatment level and pollution loading rate, are report to be intimately allied to industrialized characteristics. The industrial characteristics include geographical location, (Yu et al. 2003a, b, c; Yu et al. 2003a, b, c) departments in government, industrial sectors, grade of registration, and endeavor extent (large, medium, and small). The feature of water and extent of heavy metal content in wastewater is assorted to a great extent among different industrial sectors. For the most considerable large-scale and national-owned mineral endeavor, the irrigation utilization coefficients are usually elevated, whereas for the diminutive scale, rural community ownership, municipality, private and communal enterprise, the levels of treatment are very low (Yu et al. 2003a, b, c). The treatment level appears to be inferior and have a dwindling endeavor of extent with the geographical transition from east to west (Yu et al. 2003a, b, c). The pollutant concentrations are middling from the nonferrous industry and assorted greatly. The wastewater discharged from village and small town enterprises contains high concentrations of heavy metals; as a result they could not regularly congregate the expulsion (Sharma et al. 2015). Even though the summary metal emission quantity was low, wastewater without treatment from some diminutive civic and village enterprises resulted in astonishing metal toxic waste in a confined area, which ought to be proscribed.

9.1.2 Waste Management

The term ‘solid waste’ habitually relates to materials fashioned by human activity, and action is commonly undertaken to minimize theireffect on health, the atmosphere or aesthetics. Waste management is the utilization, purification, recycling, discarding, and treatment of solid waste that is looked after by the government or the verdict body of a city/town. There are diverse methods and fields of proficiency for each waste management involving solid, liquid, gaseous or radioactive substances. In some instances, green waste management is also carried out to recuperate assets.

Green waste management practices diverge for emergent nations, residential, and industrial producers, and they are also designed for urban and rural areas. The management for nonhazardous residential and institutional waste in metropolitan areas is habitually the liability of local government powers that be, while management for nonhazardous commercial and industrial waste is habitually the responsibility of the generator.

The waste management industry has been taking a leisurely pace toward new technology, such as radio frequency identification (RFID) tags, integrated software packages, and GPS, which enable a superior eminence data to be composed without the use of assessment or manual data entry. Technology like RFID tags are currently being used to accumulate data on presentation rates for curb-side pick-ups, which is constructive when exploring the usage of recycle bins or similar. Benefits of GPS tracking is particularly apparent in view of the efficiency of ad hoc pick-ups where the anthology is finished on a customer request basis. Integrated software packages are constructive in aggregate with this data for use in optimization of waste collection operations.

Integrated waste administration with a life cycle study attempts to propose the best option for green waste management. The quantity of broad studies signify source severance, waste administration, and collection followed by reuse and recycling of the nonorganic portion, energy, and compost/fertilizer production of the organic waste partition via anaerobic digestion to be the chosen waste management decisions. Nonmetallic waste properties are not damaged by means of burning and are able to be reprocessed/recycled in a future source exhausted culture.

9.2 Green Chemistry

The term ‘Green Chemistry’ was coined by Anastas (Anastas and Kirchhoff 2002) from the US Environmental Protection Agency (EPA). It is the “design of chemical products and processes to reduce or eliminate the use and production of harmful substances” (Anastas and Warner 1998; Anastas 2007; Anastas and Williamson 1996). In 1993 the name ‘US Green Chemistry Program’ was formally adopted, which has served as a crucial point on behalf of performance around the United States, for instance, the Green Chemistry Challenge. This does not signify that research on green chemistry did not subsist earlier than the 1990s; simply that it did not have the forename. During the 1990s, both Italy and the United Kingdom launched a major initiative in green chemistry, and, more recently, Japan initiated the Green and Sustainable Chemistry Network. The initial version of the academic journal *Green Chemistry* was guaranteed by the Royal Society of Chemistry, which appeared in 1999. The essential feature of the term is the supposition of design. It includes systematic conception, planning, and novelty.

9.2.1 Need of Wastewater Treatment

As India hurtles in the direction of a new urbanized economy, a worsening status of our atmosphere has been observed. Unfortunately, swift industrialization has increased the amount of toxins in our surroundings. Administration of waste at wastewater treatment plants in India has become crucial for our cities today.

9.2.2 Benefits

Beneficial water treatment methods do not merely manufacture hygienic reusable irrigation water but also have the possibility to bring into being assorted further benefits. They have the possibility to condense a country's waste production, to harvest methane, and to fabricate natural manure, and for the waste collected through the method, the benefits are waste reduction, fertilizer production, and energy production.

9.2.3 Information About Waste Management

The technique of wastewater management was initially developed in reaction to the adverse conditions sourced by the liberation of wastewater into the surroundings and the distress caused to civic wellbeing. In addition, as cities became larger, restricted land exists for wastewater treatment as well as discarding, predominantly by irrigation and sporadic filtration. Besides, when a population grows, the scope of wastewater spawn rises rapidly, and the deteriorating quality of this gigantic quantity of wastewater surpasses the self purification capacity of the stream and waterway bodies. Consequently, additional methods of treatment are developed to step up the forces of the natural world beyond conditions in treatment amenities of relatively smaller size. Even though clear out is obligatory to avert further expulsion of contaminated wastes into the atmosphere, development of an outlay effect technology is desired for diligent use. Conventionally, the method employed for wastewater remediation consists of the abolition of metals by flocculation, ion exchange resins, filtration, and activated charcoal (Karthikeyan et al. 2005; Vijayaraghavan et al. 2007; Wang and Chen 2009).

Generally, since 1900 to untimely the 1970s, treatment objectives included: (i) the deletion of hovering and floatable matter from wastewater, (ii) elimination of disease-causing pathogenic micro-organisms, and (iii) the treatment of biodegradable organics (BOD). The deletion treatments focused on aesthetic and ecological disquiet. The former errands of diminution and deletion of BOD, hovering solids, and pathogenic microorganism have continued, but at larger levels. The deletion of nutrients, such as nitrogen and phosphorus, has also begun to be addressed, particularly in some of the streams and lakes. Major initiatives have been undertaken around the globe to accomplish more effectual and prevalent treatment of wastewater to maintain the excellence of the surface waters. The endeavor is owing to (i) a comprehension of the adverse long-term effects caused via the discharge of some of the specific constituents established in wastewater and (ii) an increase in the understanding of the environmental effects caused by the wastewater discharges. Since the 1990s, as a time of enlarged scientific awareness and an extended information base, wastewater treatments have begun to focus on the health concerns associated with tainted and potentially noxious chemicals that are unconfined into the milieu. The waterway feature improved the objectives of the 1970s and has continued, but the emphasis has shifted to the definition as well as deletion of noxious and trace compounds that could feasibly be the origin of long-term health effects and adverse ecological impacts. As a result, though the past treatment objectives remain valid today, the imperative grade of treatment has increased drastically, with the addition of supplementary treatment objectives and goals.

The characteristics of Dewat's system consists of primary, secondary treatments and discarding (or utilization) of solids and treated water. The primary treatment might be as trouble-free as a septic tank, to eliminate settleable solids, and endow among restricted anaerobic treatment which canister should be used in the vicinity of poor soil and high groundwater. Modification of the over system enables aerobic treatment of the effluent and thwarts perched solids from inflowing to the secondary treatment. Because they are economical, and as a result have little continuance, they are prone to failure and even when in effective service may tranquilly secrete a pathogen rich waste stream. Secondary treatment options, based on sand filters, provide effectual deletion of pathogens in areas with deep permeable soils, but are ineffective in other locales with highly porous soil types. A noteworthy quantity of attention has been given to the use of organic systems meant for deletion of radio nuclides and heavy metals from solutions, and (Massoud et al. 2009; Parkinson and Tayler 2003) made a wide-ranging chapter on the existing treatment methods. A variety of predictable methods for wastewater treatment exist from primeval times, (Narmadha and Selvam Kavitha 2012; Pawar Avinash Shivajirao 2012; Turovskiy 2000); however, they are extremely pricey and thus not economical. The exceedingly developed newfangled green technology methods are being introduced to prevail over the conformist methods of wastewater treatment (Dangelico and Pujari 2010). The study chapter is allied to new green technological methods, which prove to be more advanced than the predictable methods.

9.2.4 Wastewater and the Necessity for Wastewater Management

Contaminated water is released from various industries. The sources of irrigation pollution are from sewage and industrialized waste. By means of these sources from the inhabitants of India, and the phenomenal swiftness of the escalation of its industrialized landscape, the volume of wastewater is also rising at an alarming rate. Adding to this the attenuation of freshwater sources, for instance, river, groundwater, and well water, so as to have an alarming circumstance. Very soon irrigation water may become a premium commodity.

The growing levels of wastewater have become of great consequence. Not only is it unfit for utilization but it also can mix with other sources and pollute them as well (Albadarin et al. 2017). For instance, the tainted water pollutes the river, and when this watercourse run downstream and it joins other water sources, such as other rivers, the contamination further spreads. Wastes also seep into the earth and contaminate the underground water source. Thus, now-a-days almost each source of water is heavily tainted, from the rivers to the coastal areas.

Water is essential and intended for all; therefore, the treatment of water is of the uttermost seriousness. Consumption of irrigation water is meant for all creatures. Irrigation water is essential to farming, the food industry, and livestock. To a minute degree, nature can react with reasonably fashioned noxious waste akin to human being and mammal waste. On the other hand, the enormous quantity of wastewater today cannot be managed by nature alone.

Several effects of rising levels of wastewater are summarized:

- Lack of drinking water
- Adverse effect on groundwater
- Harmful effect on river and marine life
- Soil pollution
- Superfluity of hazardous chemicals, some of which are unremitting
- Rise of pollution in coastal areas
- Increase in unremitting health circumstances associated with lethal chemicals, such as mercury and lead, in all creatures.

The investigative upshoot in the field of health related to water safeguards and a change in civilization environmental consciousness (type of weather and assets defense) obliged a new perspective concerning wastewater treatment. The plant designed for treating wastewater will become the source overhaul provider for human beings and water bodies (Millennium Ecosystem Assessment [MEA], 2005), vigor overhaul provider, and manufacturer of stipulated tilting products, including water fertilizers. Sustainable wastewater treatment consists of the subsequent safeguards (Schaum 2016; Schaum and Cornel 2016).

Health safeguard: Defense of sanitized necessities, including antibiotic resistant microorganisms acquiescence with features standards for daily handling in water bodies contributing hygienically harmless water for water reprocessing.

Water safeguard: The diminution of eutrophication via nutrient abolition (phosphorus and nitrogen) to the utmost feasible scope, abolition of nanoparticles, microplastics, and micropollutant for the safeguard of marine fauna and from the viewpoint of precautionary health care.

Resource safeguard: The diminution of source utilization for wastewater treatment, for instance, in service materials and vigor, reduction of ecological impact; source resurgence by consuming resources contained in wastewater, predominantly energy, nutrients, and water. To make all of this doable, it is crucial to coalesce skill and operation optimization; therefore, identifying synergy needs to be exploited.

9.2.5 The Physico-Chemical Treatment

Noxious wastes are habitually classified according to diverse techniques and size, where bigger particles are estranged during filtration, floatation, and gravity and smaller particles are much more complicated to detach. That is why this treatment is predominantly useful.

Chemicals known as coagulants and flocculants are used to detach them. This is a frequently used technique to treat industrialized waste. It is ideal for the deletion of hovering matter, such as grease, oil, metals, and liquefied material as well as non-living material.

9.2.6 Natal Treatment

In this method, a membrane based system is used for recycling the wastewater. A membrane bioreactor combines the use of the unproblematic science of ultra filtration with a bioreactor to treat wastewater. In short, the method coalesces the corporeal process with the natal method. This is a frequently used method in industrial and metropolitan wastewater management. Treated water is recycled for assorted intentions, such as irrigation.

9.2.7 Zilch Fluid Liberation Scheme

Several inhabitants analyze this as a periphery skill in wastewater management. It confiscates all liquefied solids from the wastewater, leaving purified water. A technique like RO is used to decontaminate the water. There is a large area where the necessity for wastewater management is great. Some of the areas of operation for wastewater treatment plants in India are:

- Metropolitan water management for urban and municipality
- Large building societies or colonies
- Desalination
- Designed for use in rural regions, such as irrigation
- Industrialized segment

Some of the challenges still faced in India are:

- Apathy by some governments
- Lack of civic confidential partnership on wastewater management
- Lack of awareness
- Disproportion in the quantity of wastewater and handling plants
- Lack of a cohesive nationwide campaign

In India, the treatment plants have become an imperative component of the countryside crucial for sustaining the health of our public and the earth. Green technology has brought new technology to the treatment of wastewater.

9.3 Green Technology (GT)

GT is an ecological curative technology that diminishes the ecological damage resulting from the products and technology for citizen's conveniences. Currently, advancement in corporations have lead to further thought toward GT, helping to enhance green capabilities (Hekkert and Negro 2009; Pujari 2009; Berrone et al. 2013). Green technology can improve material along with waste consumption, energy efficiency, and recycling.

In support of these benefits, GT not only enhances ecological features but also encourages the potency of a nation's financial system (Shrivastava 1995; Aithal 2015a, b, c). It is supposed that GT promises to develop farm effectiveness while simultaneously minimizing ecological degradation and conserving innate assets. GT is a sustainable technology that will not generate a footprint, and it is used for an assortment of processes. GT maintains the use of innate macrobiotic resources and stays away from the manufacture of emerald gas. GT also uses fewer sources and does not support enlarging the entropy of the earth. GT supports the mechanization of each process and hence avoids human interference.

The foremost technologies used in present day, including space technology, internet technology, atomic, nuclear technology, automobile technology, computer technology, aircraft technology, renewable energy technology, biotechnology, nanotechnology, telecommunication technology, etc., can be made green using the principles of green technology (Sridhar Acharya and Aithal 2015; Han and Liu 2009; Guoliang 2011; Aithal and Aithal 2015a, b). Such GT might enable solving both basic and superior problems. At the moment, industrial and technological progress in emergent countries is budding swiftly, and ecological problems as well as others must be considered. As a result, novel green technology research promotes ecological and monetary development (Hasper 2009). Inside this section, our aim is to present effectual green technology for treatment of waste.

9.3.1 Class of Green Technology

Jade technologies cover an extensive province of fabrication and utilization technologies. The espousal and use of green technologies entails making use of ecological technologies to observe and assess toxic waste deterrence, manage, remediation, and renovation. Thus, the monitoring and appraisal technologies are used to resolve and follow the circumstances of the environs, over and above, the expulsion of innate or anthropogenic supplies of a detrimental nature. Avoidance technology evades the manufacture of environmentally perilous materials or alters traditions so as to lessen harm to the milieu; it encompasses product swap or the redesign of an intact creation development sooner than by means of the original portion. Risk management technology deals with things that are undisruptive earlier and then penetrate the surroundings. Remediation and reinstatement technologies exemplify the method proposed to advance the stipulation of ecosystems besmirched by unsurprisingly induced or anthropogenic things (2003 United Nations environment programme environmentally sound technologies for sustainable).

9.3.2 Sectors of Green Technology

1. Water and waste management: Solid waste management, Sewage treatment, Recycling technology, and Water purification.
2. Agriculture: Organic agriculture.
3. Building: Building performance technology and Sustainable building material.
4. Transportation: Electric vehicle and Rail transport.
5. Energy: Efficiency technology and Renewable energy technology.

9.3.3 Advantages of Green Technologies (AGTs) Toward Wastewater Management

This refers to the process of removing the contaminants and undesirable components in domestic, industrial, and polluted waters to safely return it to the environment for drinking, irrigation, industrial, and other uses. Today, the increase in ecological awareness and enhanced government regulation has made some conventional wastewater treatment systems questionable. To fill the gap left by less than adequate conventional technologies, AGTs are tested, vetted, and implemented as clean alternatives for wastewater treatment purposes.

Several steps are basically employed during any wastewater treatment process. The first consists of separating the solids from the liquid water. This is achieved through gravity as solids are heavier than the liquid water. Other solid components, such as oils and woods, which are less dense than liquid water, could be removed from the water surface through separation. Afterward, the liquid wastewater is subjected to filtration processes to dispose of any colloidal suspensions of fine solids, chemicals particulates, and impurities. The resulting filtered water is finally exposed to oxidation on the way to trim down or eradicate the toxicity of any remaining noxious waste and disinfect the wastewater before releasing it to the environment. Currently, a number of AGTs methods are tested and used for wastewater treatment either alone or in combination with other conventional methods.

9.3.4 Objectives of Advanced Green Technologies (OAGTs)

Advanced green technologies (AGTs) refer to a group of practical methodologies and materials based, among others, on nontoxic chemical processes, clean energies, and environmental monitoring to slow down or correct the negative impact induced by human activities. Advanced green technologies are aimed to provide better sustainability through securing our societal needs without further damaging or depleting the remaining natural resources. This could be achieved through:

- Setting up economical models to implement and commercialize related innovations by encouraging the creation of jobs and novel careers in the field.
- The recycling of manufactured goods and products.
- Development of clean alternative technologies and energies to replace those proven to negatively impact health and pollute the environment.
- Decreasing the pollution caused by the waste release as well as contamination through improving the behavior of human manufacturing and expenditures.

9.3.5 Green Technology Four Pillars Policy

Social: Get better quality of life for all (Luken and Van Rompaey 2008) through the use of technology.

Milieu: Marmalade and lessen the impact on the atmosphere.

Financial system: Augment the nationalized fiscal enhancement.

Vigor: Inquire about the route for arriving at vigor independently and encourage efficient exploitation.

9.3.6 Benefits of Green Technology

1. Does not produce hazardous wastes into the atmosphere.
2. Renewable; will never expire.
3. Be able to fetch monetary benefits to assured area.
4. Requires less upholding, so you do not need scores of capital to operate it.
5. Slow global warming by plummeting CO_2 emission.

9.3.7 Drawbacks of Adopting Green Technology

1. Lack of human resources and skills.
2. No known alternative process technology.
3. Lack of information.

4. High implementation costs.
5. Uncertainty about performance impacts.
6. No renowned unconventional chemical or unrefined fabric inputs.

9.4 Jade Industry Initiative

An association through the ‘jade economy’ and sustainable advancement concept, akin to the ‘jade economy’ and ‘jade industry’, is seen as a main and realistic alleyway toward accomplishing sustainable improvement. The influence of the ‘jade economy’ is to achieve enhanced human being welfare as well as public fairness, while simultaneously diminishing ecological jeopardy and protecting environmental scarcity. The ‘jade industry’ transforms a developed and associated diligence sector via introducing further efficient, source prolific, and dependable utilization of untreated resources. Consequently, they furnish extra efficiency toward sustainable industrialized enhancement.

The jade industry is the zone strategy intended to recognize the jade economy as well as jade augmentation, and eventually, toward a sustainable progress improvement opportunity. Presently, there are numerous benefits for pursuing a jade industry approach. The jade industry offers a sensible alleyway in the direction of long-term fiscal improvement and sustainable improvement, thereby unbolting enterprise progress to their source production as well as ecological presentation and ascertaining a pioneering operation so as to deliver ecological cargo and armed forces (create green industry). This is indispensable from social, monetary, and ecological perspectives, particularly as Green diligence ropes:

9.4.1 Revenue and Employment Formation

Superior dissipate executives, projects, renewable liveliness, resurgence services, stipulation of other ecological possessions, and services create jobs and provide a resource of revenue, including for underprivileged communities with inferior formal proficiency levels.

9.4.2 Gung Ho and Sustainable Trade

Condensed outfitted outlay owing to the abridged consumption of supplies, vigor, and stream, as well as of minimization of dissipate and secretion generation, while assuring a link of trade in illumination of tapering consumer necessities meant for ecological and social revelation and recital.

9.4.3 Innate Resource Precautions

Condensed exploitation of irrigation, supplies and stimulates alleviation of the stress lying on the now scant resources, which are all anticipated to become scarcer in days to come if current inhabitant, urbanization, and improvement tendencies persist in the future.

9.4.4 Ecological Executive

Condensed generation of dissipates and emissions lessen the contamination encumberment on the innate ambiance and biodiversity.

9.4.5 Industrial and Chemical Protection

Enhance operation, sustain, and deal with flora that make use of chemicals maturely to pose less jeopardy to recruits and community.

9.4.6 Visual Aid the Lane

Jade industry canister is achieved by a quantity of concerted proceedings:

9.5 A. Greening of Diligence

Allows and props up the entire diligence despite their region, magnitude or location, to jade their operations, methods, and products to:

9.5.1 Exploit Resources Powerfully

Elevate the productive utilization of resources, water, and vigor in industrialized invention, by such approaches as: dematerialization of products with worthy manacles; utilization of resources by means of longer overhaul of natural life; surrogate of virgin resources with cast-off supplies; recycling, reclaiming, and revitalization of materials; use of supplies, water and vigor as sustainably administered and/or low impact sources.

9.5.2 Lessen the Generation of Waste and Emission

Lessen and wherever possible eradicate the formation of waste and emissions inside factory, by such approaches as: enhancement in the method of maintenance, monitoring, and operation; dissipate minimization; application of superior process technology with superior effectiveness as well as specificity; recycling, recuperation, and reclaiming of process rivulet.

9.5.3 Lessen Peril Allied with Chemical and (Perilous) Waste

Lessen peril allied with fabrication, make use of and dispose of chemicals, by such approaches as: sound executive of chemical; phasing out of venomous and other environmentally detrimental substances; relevance of the most excellent ecological practice and most excellent accessible modus operandi to prevent unintended formation and emissions of pop and further perilous poisons; proxy of chemical processes by non-chemical processes (biological, physical, etc); and substitution with safer, extra specific, and/or more effectual unconventional chemicals.

9.6 B. Construction of Jade Industries Ascertains and Enlarges (Innovative) Jade Industries That Furnish Ecological Freight and Services To

9.6.1 Diminish, Recycle, and Reprocess Waste Materials

Shore up industry to develop and deliver superior incorporated waste executives, reprocess and resource revival technology, services and systems, for saleable, civic, edifice, demolition, industrialized and other definite waste streams, and generate trustworthy materials of recycled supplies and products.

9.6.2 Improve Industrial Vigor Efficiency and Create Use of Renewable Vigor

Shore up industries to management systems, products, equipment, deliver technology, recognize services that augment industrialized vigor efficiency and the use of renewable vigor (bio and solar, etc.) or extra low carbon vigor sources (in fastidious waste warmth).

9.6.3 Accumulate, Cope, and Arrange (Perilous) Waste and/or Emissions Within Environmentally Compatible Traditions

Prop up industry on the way to develop and deliver technology, equipment, executive systems, products, be acquainted with how services accumulate, cope and arrange, devoid of threats to the atmosphere, (perilous) waste and/or emissions, counting for exemplar chemical electronic waste, curative waste, etc.

9.7 New Technologies

9.7.1 Why We Need Advanced Treatment

The utilization of conservative irrigation water and wastewater treatment processes has become even more challenging through recognition of increasing noxious waste, fast augmentation of inhabitants, and industrialized tricks along with declining ease of use of the stream resources because the waste matter of unusual secondary treatment shows tranquil restraint of 20–40 mg/L BOD, which might be abhorrent to several streams. Hovering solids, which accumulate and contribute to biochemical oxygen demand (BOD), might perchance reconcile on the torrent bed and inhibit the aquatic existence. The BOD of discharge in a tributary by a low stream is able to cause harm to aquatic existence by tumbling the dissolved oxygen content. In addition, the secondary effluent contains a considerable amount of dissolved solids and plant nutrients. If the dissipate water is of industrialized derivation, it might also retain traces of unrefined chemicals, heavy metals, and additional contaminants. Diverse methods are used within advanced dissipate treatments to gratify any of the numerous specific goals, which comprise the erasure of (1) venomous substances, (2) BOD, (3) hovering solids, (4) dissolve solids, and (5) plant nutrients. These technologies make the option available for better civic health and the milieu. The emphasis is positioned on their basic ideology, focal relevance, and narrative improvement. Advantages and drawbacks of this technology are compared to emphasize their modern confines and future research requests. It can be considered that, along with the emergent familiarity and the advances in industrialized diligence, the relevance of these technologies will be increased at an unprecedented scale. These treatment technologies may be introduced at any juncture of the treatment process, such as in the casing of industrialized watercourse or might be used for the entire deletion of contaminants subsequent to secondary treatment.

9.7.2 Automated Chemostat Treatment (ACT)

Automated Chemostat treatment is a description scheme in the handling of slush. This skill is flexible and simple to integrate; it is totally computerized, controllable, and significantly more efficient than the existing practice. The systematic concept of automated chemostat treatment is the use of a suitable bacterial cocktail in support of a known category of tainted irrigation water to get a novel chemostat. The process is maintained within an affirmed balance of bacterial escalation and natural composite degradation. Because of the low concentration of bacterial cells, no aggregate is fashioned and each bacterium acts when a single cell boosts the surface vacant for the method and enables the biodegradation at a much superior effectiveness. The domino effect is an almost slush gratis output of water that can be returned straight to the milieu or advanced to the next process. Automated chemostat reduces COD, hydrocarbons, suspended solids, and TOC from oily waters and slippery, parting fine effluents below industry regulation levels. On the basis of a water sample from the refinery, ACT determines the most efficient solution to treat the specific refinery issue. The hydraulic age and the bacterial age become equal, requiring a lower density of single cell bacteria. This ACT operates as an unremitting flow reactor devoid of activated sludge. The bioreactor can thus be relevant on site, where using accessible infrastructure with high suppleness for intonation for the method saves considerably in effectual and continuation outlay.

Advantages

The advantages of this simplify the scheme by plummeting chemical treatment and bio sludge as well as reducing black sludge formation. Its litheness and modularity permit it to embrace low and high capacity contamination, be used for fresh and salt water, be simply modified, and have augment capability. Production is nearly sludge free, gathering the strictest disposal values. This trailblazing "green" process is effortless to change and can be used in diverse sites, including oil refineries, oil storage farms, contaminated reservoirs, drilling sites, marine ports, and storage tanks.

Full Control from Any Point for Every Point

The completely automated system comprises an assortment of online sensors that feed the management unit information on different parameters for instance: dissolved oxygen, TOC, nitrogen, TPH, and temperature. The regulators ensure the finest process balance is upheld among the additives, organic compounds, degradation flow rate, and bacterial growth.

Application

1. These technologies directly address the three focal disadvantages of predictable water treatments in refineries: initially, there is no necessity to reactivate bio slush.

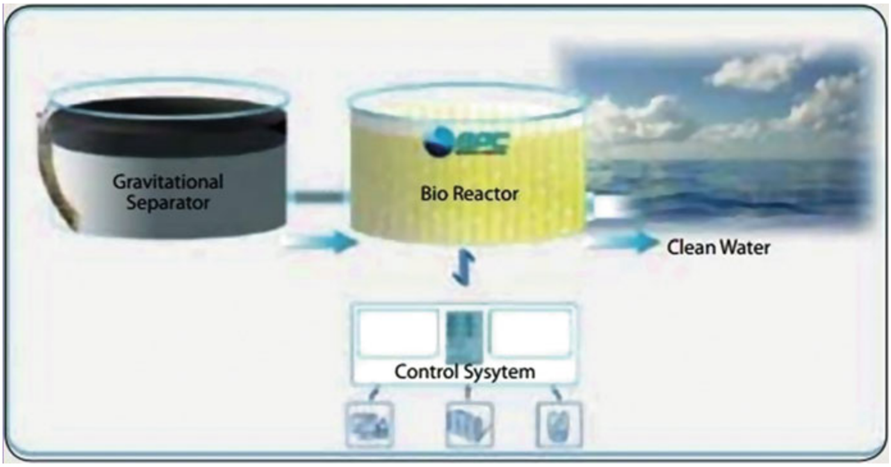

Fig. 9.2 Diagram for automated continuous flow system

2. ACT eliminates the requirement of the DAF process and saves time.
3. Productivity, which is practically sludge free, can be dumped directly in nature by tumbling bio slush sources and the creation of black slush, as well as adequately eradicating nitrogen. Its output meets the strictest discarding values, necessitating no further handling.
4. ACT offers a vastly effectual treatment of side torrent, which is regularly the origin of tragedy in conservative treatment processes. Side torrents impact the most, originate traffic jams, and further stern procedures.
5. It can be executed devoid of an inclusive extra treatment scheme.
6. Permits severance of heavily polluted rivulet and amplifies overall output.
7. Provides an efficient manner to rupture loss and PAH, eliminates oil, other organics, and phenols.
8. The patented process exploits inimitable bioremediation technology to trim down COD, hydrocarbons, TOC, and suspended solids from oily waters and slippery departure effluent of high quality reunion stringent industry values.
9. The bioreactor can be functional on-site (using the available infrastructure) owing to its elevated litheness in process intonation. This spectacularly lessens the equipment and maintenance outlay (Fig. 9.2).

9.7.3 Membrane Bio Reactor (MBR)

Membrane Bio Reactor (MBR) technology is based on the array of predictable activated mire handling together with a course of action filtration by a membrane with a pore volume between 10 nm and 0.4 microns (micro/ultra filtration), which allows mire division. The membrane is a hurdle that retains all particles, colloids, bacteria, and viruses of treated irrigation water. Also, it can operate at upper concentrations of mire (up to 12 g/l as an alternative of the standard 4 g/l in predictable systems), which significantly reduces the volume of the reactors and mire formation. Although there are currently two leading procedure configurations of biomass rebuff MBRs, side stream (SMBR) and underwater or engrossed (IMBR), the engrossed configuration is the most extensively used in community wastewater solutions owing to the inferior related outlay of operation. Here, the component is located directly in the process reservoir and is therefore less energy intensive, while as an end result, it is only compulsory to generate a trivial vacuum within the membrane component, considered as trans membrane pressure (TMP) for filtration.

In support of the absorbed configuration, mostly two types of profitable membrane modules are obtainable: flat sheets (FS) and hollow fibers (HF). Hollow fibers permit a higher packing density due to thinner spaces among membranes compared to flat sheets. Nonetheless, these make it further vulnerable to membrane congestion and/or sludging, and it can also make crackdown extra tricky. The membrane materials used for an IMBR are fluorinated and sulfonated polymers (polyethersulfone, polyvinylidene, difluoride in fastidious), which dominate in saleable membrane MBR products. It is indispensable to cram the mechanism and factors that contribute to membrane fouling in MBR. Normally, these factors have been classified in four discrete groups: nature of the sludge, operating parameters, membrane/module characteristics, and feed wastewater.

9.7.4 Membrane Filtration

It involves the running of water containing impurities across a membrane. Running water pervades all the way through the membrane into a divided conduit for improvement. Because of the cross-flow collection of water and the overwhelming ingredients, resources at the back do not move up to the membrane surface but are passed out of the system for adjusted recovery or elimination. The watercourse transitory in the membrane is called pervade, although the water with more concentrated materials is called the concentrate or retentate (Fig. 9.3).

Membranes are constructed of roughage or other polymer matter, by means of a highest pore size put down during the industrialized process. It is necessary that the membranes elude passage of particles the size of microorganisms, or about 1 micron (0.001 millimeters), and therefore that they remain in the process. This means that the MBR system is fine for eradication of solid materials, but the deduction of a liquefied wastewater apparatus must done and facilitated by means of the accompanying management steps.

Membranes can be configured in a number of ways. For membrane application, two configurations are primarily frequently used for hollow fiber groups in bundles, as revealed in Fig. 9.4. The hollow fiber bundles are connected by manifolds in the unit so as to be calculated for easy alteration and service. This type of membrane

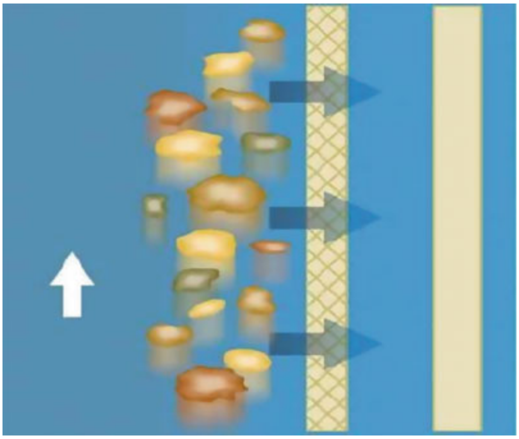

Fig. 9.3 Diagram for membrane filtration process

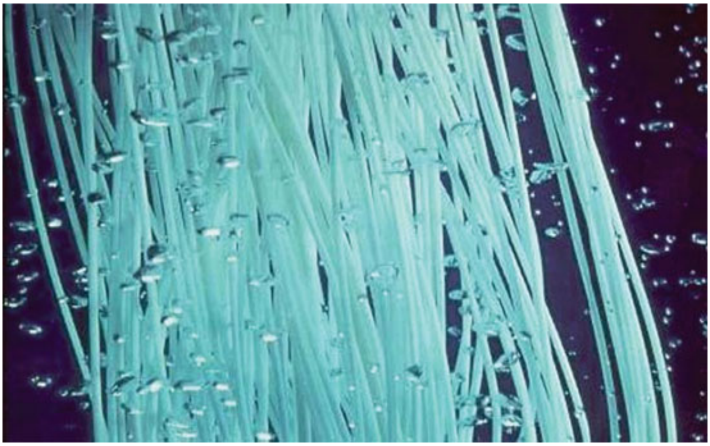

Fig. 9.4 Diagram for hollow-fiber membrane system

existence can be achieved, or even improved on, for 10 years. On the subject of permeability, a correlation of permeability loss and operation time was established from research, demonstrating that the membrane permeability reaches a nonoperative value after 7 years of operation (Sebastian et al. 2011).

9.7.5 Wet Air Oxidation (WAO)

In the aqueous industrial treatment, the misuse of effluents is a considerable and necessary procedure, with several techniques employed. WAO is one of the available technologies for the management of aqueous wastewaters. In wet air oxidation, aqueous waste is oxidized in the liquid phase at high temperatures (400–573 K) and pressures (0.5–20 MPa) in the presence of an oxygen containing gas (usually air). This technology consists of techniques to heat transfer and the use of both homogeneous and heterogeneous catalysts to enhance reaction rate. WAO is a hydrothermal process suitable for the oxidation of organic and inorganic components or pollutants in aqueous misuse streams. High hotness and eminent pressure are requisite, commonly operated inside the superheated water range (<300 °C, <20 MPa). Usually, the higher the hotness, the higher the level of oxidation achieved, and the connected requirement of pressure is essential to maintain the fluid state. Oxygen limited pressure and residence time is also crucial to the degree of oxidation. Residence times can variety from seconds to hours depending upon the nature of the material to be oxidized, and obviously limited to the most difficult components to corrode when bearing in mind complex mixtures, such as industrial and municipal misuse streams.

Wet Air Oxidation of Wastewater Slush

In misuse water treatment, the primary use of alum (or alternatively ferric salts) is as a coagulant or as a phosphate precipitant, via formation of insoluble aluminum phosphate. Alum and phosphates may therefore be alienated from the fluid aqueous watercourse by WAO as a considerable economic benefit to this procedure. The organic module of the mire is significant in terms of proportion and overall quantity, and amongst other criteria it is essential to be detached from the aqueous watercourse. The analysis of COD provides a suitable measure of the organic matter. A primary benefit of this method is a considerable reduction in COD of the fluid output (Paul et al. 2012).

WAO Process

We recognize that wet air oxidation is the oxidation of soluble or perched gears in water using oxygen as the oxidizing agent (Fig. 9.5).

Features & Benefits

1. Pretreatment of high force wastewater to create eco-friendly residual organics.
2. Low operating costs and minimal air toxic waste discharges.
3. Destruction of specific compounds.
4. Removal of toxicity or reactivity.
5. Procedure fluid treatment for recycling/recovery.
6. Gross reduction of chemical oxygen demand (COD).

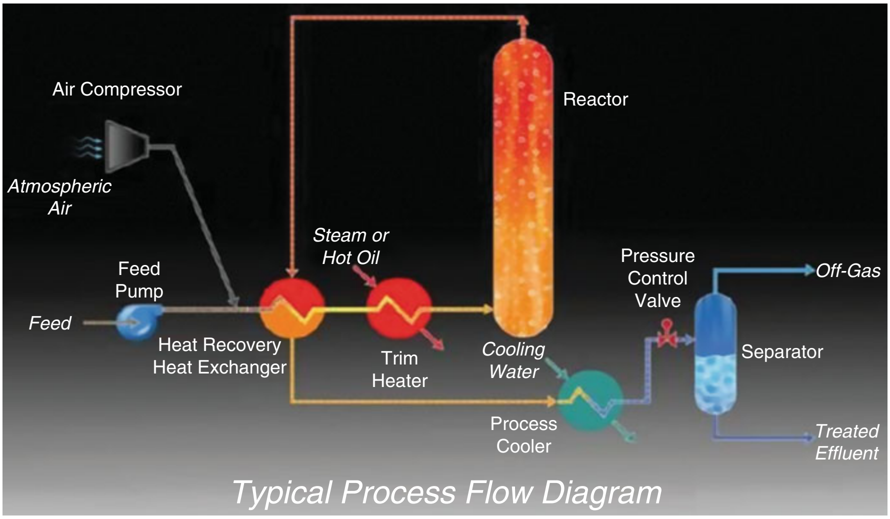

Fig. 9.5 A typical flow diagram of wet air oxidation process

Disadvantages

1. Elevated capital costs.
2. Safety implication connected with a scheme in action by such rigorous in service circumstances.
3. In the design of the procedure, equilibrium has to be reached connecting the improvement of the reaction rates with hotness and pressure adjacent to their consequences on capital cost and operational difficulties, such as deterioration and scaling of apparatus.

Application

1. Treatment of towering strength wastewater, comprises tired caustic streams create by ethylene off rockers and refineries.
2. In method, for treatment and recycling/recovery of procedure fluid streams.
3. Biological mire conditioning and demolition.

9.8 Technology Classification

Membrane separation is currently exploited as a support or surrogate planned for habitual watercourse and wastewater treatment technology, such as biological filtration or corporeal and chemical solutions. They are rapidly gaining acceptance all over the planet, and for the most part the victorious and reasonably priced water

Table 9.1 Taxonomy of membrane-based water filtration

	Membrane type	Configuration	Material
Membrane	Microfiltration (MF)	Pipe-shaped membranes: capillary, hollow fiber or tubular plate-shaped membranes: flat plate or spiral	Organic (Polymeric)
	Ultrafiltration (UF)	Plate-and-frame, spiral-wound, and tubular	Inorganic (Mineral)
Applications	Water Treatment (incl. Desalination) and Wastewater Treatment		
End users	Industries, Municipalities and communal applications, Desalination plants		

Copy right © 2013 (Source: Frost and Sullivan 2013: CEO 360 Degree Perspective on the Global Membrane-based Water and Wastewater Treatment, Mountain View)

treatment schemes are easy to get to (Pall Corporation 2015). At first membrane separation was used for grounding of procedure water, though its services have expanded owing to its merit within wastewater solutions and intake water decontamination practices by means of the plan to retain microorganisms in desalination and irrigation water softening. Membrane separation is based on discerning filtration by pores of different sizes and consists of four leading membrane types: reverse osmosis, ultrafiltration, nanofiltration, and microfiltration. Every part of these types are disparate particles from the nourished watercourse. Ultra- and microfiltration is deployed generally for particle removal, while reverse osmosis along with nanofiltration is used for desalination and softening. Membranes for water filtration differ within stipulations of aperture size. The smaller the aperture, the greater the applied pressure disparity must be to squash the water course through the membrane. Relatively bulky particles can be alienated through ultra- and microfiltration. However, particularly in the cases of desalination andsoftening, there are minor particles which require exclusion. During such situations, the most appropriate solution is to deploy reverse osmosis or nanofiltration. These membranes are not permeable resources with defined pore size; however, the homogeneous polymer layer retains assured substances owing to their particular formation. The technology taxonomy of membrane-based water filtration is summarized in Table 9.1

9.8.1 Membrane-Based Technology

9.8.2 Membrane Filtration Systems

Membrane systems are crucial to the enlargement of superior water retrieval systems, and the progress of innovative and enhanced systems is predicted to continue. Engrossed micro- and ultrafiltration membranes afford an admirable pretreatment for RO, which can eliminate an extensive array of liquefied ingredients. Besides, the growth of membrane filtration systems have lead to the improvement of both highly developed water treatment technologies and MBRs, which are swiftly attracting the diligent workhorse of water repossession.

Among MBRs, residence times of natal solids are augmented, making probable extra biological treatment and the upholding of pathogens; treatment by means of MBR produces an extremely elucidated effluent that can be merely sterile. Consequently, treatment with MBR is ideal for turning out non drinkable water. In favor of the retrieval of filtered water, MBR has to be followed by UV and RO treatments (Tao et al. 2005, 2006).

9.8.3 Ultra Filtration

Ultrafiltration is a contemporary water and wastewater filtration tool that has a low pressure-driven membrane, which is tremendously effectual with the supplementary benefit of low energy utilization (Van der Vegt and Iliev 2012). It is a membrane that allows particles smaller than 20 nm to go through it and the aperture sizes vary between 20 nm and 0.1 microns. The function of this membrane system is escalating in the water and wastewater treatment sector and in industrial process severance. A few of the key applications for these membrane systems are in desalination, pretreatment processes, ingestion water treatments, and membrane bioreactors. In the industrialized sector, some definite preferences exist, for instance, as an emphasis on admirable pH and temperature resistance. A stipulation for low foul propensity of filter is also an imperative, even though it is not specifically insisted on in industrial processes. The key applications for these membrane systems are in the victuals and beverage quarter (including a strong stipulation in the dairy industry on behalf of such products), the attention of macromolecules in biotech, the fabrication of ultrapure water for microelectronics, in general industrial wastewater treatment, and oil emulsion waste (Synder Filtration 2015). These membranes are fashioned via assorted suppliers among precise configurations that depend on the contour and material of the membrane. These configurations have a specific use and that is accompanied by advantages and disadvantages. The most crucial influence of the configuration is the mechanical stability on the system and requisite hydrodynamic and fiscal constraint. These membrane module approaches are in capillary or hollow fiber configurations (pipe-shaped membranes), tubular, frame or spiral wound configurations (plate-shaped membranes), and plate. For a spiral wound, towering purity water and capillary configurations would typically be used (Lenntech 2015). The optimization of the system depends mostly on the power consumption, flow velocity, membrane fouling, pressure drop, and module cost (Dhawan 2014). In addition, there are several set ups for the identification of specific membrane configurations. The most frequently used methods incorporate dead end and cross flow filtration setups. The permutation of both dead end and cross surge also represents an achievable type for the filtration process. The forth probable set up is the filtration chamber with suffused membrane filter. This method was initially urbanized for both ultra- and microfiltration through wastewater treatments where the membrane, in combination with the chamber/reservoir, is fashioned as a membrane bioreactor (MBR). The current most accessible assortment of MBR systems use suffused membranes (Rippenger 2009).

9.8.4 Nanotechnology

Additional staged enhancements are viable in the near future (Tchobanoglous 1981). The notion is humans probed for advancement of the theater membranes through less polluted characteristics, enhanced hydraulic conductivity, and more discriminating denial/transport characteristics. Progress in RO technology includes enhanced membranes with configurations, extra efficient pumping and vigor revival systems, and the progress of process technology, such as membrane distillation (Shannon et al. 2008). Nanofiltration provides a better filtration than ultrafiltration; however, it is as a rule referred to as free reverse osmosis (RO) because of its membrane pore structure. The structure of the membrane is comparatively large when compared to RO membranes, and unlike them, it allows the passage of salts (Rippenger 2009). Nanofiltration membranes have pores with a measurement of around 1–5 nm and the molecular weight cut off for a typical membrane mendacity between 150 and 500 Dalton. Nanofiltration applications are frequently used to tackle organic contaminants and some inorganic salts as they can keep ions and low molecular weight organics. The membranes have more radically advanced water permeability than that of reverse osmosis (RO), which operates at much lower pressures. Owing to its lower energy use and higher flux rates, nanofiltration might replace RO in numerous applications (Shon et al. 2013).

To tackle macrobiotic contaminants in freshwaters, nanofiltration membrane systems are also used for the concentration of dyes, sugars, and other substances. There are a number of developed applications using nanofiltration because it is moderately frequent in the textiles, dairy and food sectors, and in chemical processing; although, the principal applications continue to be in the treatment of wastewaters, fresh processes, and desalination pretreatments (Sutherland 2009). Analogous to ultrafiltration, there are also different shapes of nanofiltration membranes, such as tubular, spiral or flat.

9.8.5 Mechanical Variable Filtration Technology

This technology affirms the treatment used and intended for wastewater handling in which a growing gush of influent is cleaned by a downward gush of sieve media. Throughout the treatment procedure itself, the sieve media is cleaned by the filtered influent; hence, there is no necessity for any bonus sieve media cleaning or fresh water. The automatic variable filtration method consists of double sets of sieve media that can be operated in string or analogous. The two juncture string configuration is used to turn out incredibly excellent filtrate. This style is ideal for distillation of secondary wastewater for reuse. The automatic variable filtration procedure is operational with actuated valves, sensors, and programmable sense organizers to mechanically change from a serial manner to analogous mode throughout soggy weather circumstances or other preset working situations.

The input benefits of the scheme are:

- Incessantly clean media bed.
- Higher solids capacity.
- Even gush allocation.
- Outlay effectual to inaugurate, low operating and prolongation costs.
- Average reject of 5–15%.
- Easy operation & maintenance.
- Elimination of ancillary equipment.
- Extremely low power consumption.

9.8.6 Reverse Osmosis (RO)

Reverse osmosis is a type of membrane division that uses pressure to compel a solution through a membrane so as to retain the solute and allow the clean solvent to pass to the other side. In general, this membrane deliberately allows water to pass through even as the solutes (for example salt ions) are being separated. It is proficient at sorting out viruses, dissolved solids, bacteria, and other elected dissolved substances and is chiefly used for the desalination of seawater (Bakalar et al. 2009; Frost and Sullivan 2013). The reverse osmosis (RO) membrane is in essence nonporous, and it preferentially passes liquid and retains the majority of the solutes, including ions (Shon et al. 2013). Reverse osmosis and electro dialysis emerged collectively as new technologies in the second half of the twentieth century; they became alternatives to the commonly used techniques of evaporation and distillation. Since then, there have been a number of advancements in most important technologies, including membrane distillation, low temperature distillation, pressure retarded osmosis, graphene membranes, and bio mimetic (International desalination Association 2013).

9.8.7 Microbial Fuel Cells

For microbial stimulate cells, a prospective advanced technology, electrical vigor naturally occurs in the dissipate stream by means of electron transfer to detain the vigor produced by microbes designed for metabolic processes (Kim et al. 2008; Logan et al. 2006). Initially, microbes are matured as a bio film lying on an electrode; the electron contributor is alienated from the electron acceptor by proton barter membranes, which ascertain an electrical current. Electrical energy is subsequently generated by the corrosion of organic matter. This technology is stable in the stage of improvement and noteworthily advanced in practice. The efficacy and economics are indispensable; it has the potential to create electrical energy directly from organic themes in the waste rivulet.

9.8.8 Innovative Municipal Hygiene Technology

The new municipal hygiene technology intends wastewater treatment by reuse of vigor and mineral deposits with an amalgamation of electroflocculation and anaerobic digestion technology. Electroflocculation treatment is based on severance of the organic contamination from population wastewater through electrocoagulation. The organic slush of the electrocoagulation reactor is made up of sediments in a globular sedimentation store; the slush is subsequently fed to an anaerobic reactor to get renewed biogas, which can be rehabilitated into vigor for captive exploitation. Anaerobic fermentation technology produces optimum biogas owing to two detached processes of hydrolysis, where the long carbon chain complex is wrecked into smaller complexes, for instance, fatty acids and methanogenesis, and the fatty acids get transformed into biogas.

9.9 Innate Treatment Schemes (ITSs)

The foremost basic consideration and depiction of the process of innate treatment schemes (ITSs) is also humanizing and enables us to use the innate process and to develop water excellence (Kadlec and Knight 1996). ITSs use a range of biological, physical, and chemical processes concomitantly to confiscate a wide array of noxious wastes. For instance, this scheme is increasingly being used to detain, maintain, and treat tornado water, thereby converting this “nuisance” attached to a precious source of water. These innate views have the benefit of being capable of eradicating a wide assortment of micro pathogens, constituents, counting nutrients, and noxious wastes. They have long proven to be effectually designed for the treatment of potable water; ITSs are increasingly being used for water retrieval.

9.9.1 Analytical Dissipate

Analytical processes vary in the quantity of dissipate created. The greenest methods produce no dissipate or create merely a diminutive volume of dissipate (Keith et al. 2007). Commonly, the more steps in an analytical scheme, the more reagents consumed, and the higher the volumes of analytical dissipate. Therefore, diminution in the use of reagents by the techniques discussed above contributes to lessen the manufacture of dissipate. An additional imperative issue is ensuring the appropriate treatments of analytical dissipate. The toxicity of dissipate may be condensed during recycling, degradation, and passivation of dissipate, preferably executed on the line (Garrigues et al. 2010).

9.9.2 Coke Oven (CO) by Product Wastewater Treatment

In India, steel producing plants use this treatment method to convalesce ammonia from coke ovens. Water contamination trouble would subsist if ammonia is not recovered, which is the main contaminate amongst all dissipates from production. In the CO effluent, the majority of the contaminants are liquefied. Additional contaminants are subjected to biological treatment along with residues of phenol and ammonia. The two main processes frequently used for the treatment of coke oven effluents are dribble filter and the activated slush process.

9.9.3 Urine Unraveling Method

Urine is a division of familial wastewater which contains 50% phosphorus and 90% nitrogen. The upgrading of urine unraveling toilets and technology for treating it create compost products that are key for managing nutrients with minimal necessities for exterior assets, for example, additional energy. To produce the identical quantity of fuel based on nitrogen rich fertilizer takes a huge quantity of vigor and nonrenewable resources. Urine unscrambling toilets have already been developed, and advanced research is also going on to further refine and utilize them for wastewater management and creating resources.

9.9.4 Root Zone Treatment

1. Handling of familial wastewater, especially for petite towns, hotels, resorts, rural community, hostels, etc., is effortlessly probable and affordable because it engrosses maintenance cost, low capital, and operation.
2. Root zone treatment canisters also treat eco-friendly built-up effluents, especially effluents from agro based industries, such as those seen at Kids Leather (Tannery effluent), the Chennai CPCB project at Mother Dairy, and the Delhi and Industrial effluent of Proctor and Gamble at Bhopal.
3. Root zone treatment can be applied in Urban Watershed Management by treating the exposed nullah in a decentralized manner and in receipt of the treated dissipates either for dilution purposes or irrigation.

9.9.5 Water Hyacinth Eco-Technology

This technology provides outlaying effectual solutions to dissipate water issues in many precise areas (Trivedy 1998). This is based on waste treatment and was endeavored in Singapore, Malaysia, the US, India, and Japan. India initially designed some for 2–5 years with most studies coming from the United States. Victorious pilot projects are familiar (Mandi 1994; Brix and Schierup 1989). The treatment of wastewater by water hyacinth has been effectively executed by the conurbation of San Diego, USA, to generate an indulgence waste matter quality standard that would be estimated from advanced secondary treatment methods. Current research efforts have exposed that this technology exploits wastewater treatment in universal dispersion. Conventionally, it was used merely for sewage treatment and a few industrial diverse types of dissipate and chemical species are employed for treatment by means of water hyacinth. This technology has shown promise in elimination of venomous organic dissipate, including almost all metals and radioactive dissipate. It has emerged that the plant has a notable capacity to confiscate an exceptionally wide range of substances and a large number of them are yet to be tested.

It is being used in amalgamation with other flora to obtain enhanced recital. Aquatic fish culture is being increasingly used in hyacinth treated water; algal control in water after secondary treatment is furthermore accomplished by water hyacinth. In tremendously underprivileged countries, where water course paucity is acute and hygiene is appallingly low, particularly in rural areas, water hyacinth can be used to make clean water points depleted of waste available. It is also proposed not merely as a water sterilizer but also to generate income for the rustic poor (Trivedy and Thomas 2005).

Biomass operation ought to be a crucial part of the hyacinth based method. It is imperative to recognize economical methods for the discarding and/or exploitation of the large quantity of solids that can be spawned by the water hyacinth treatment process. The microbial environmentalism of hyacinth-based systems, in particular the role of poised and attached escalation, needs to be investigated in detail.

The design parameters developed require validation in miscellaneous situations for diverse kinds of dissipates. Superior effectiveness during microbial growth/ higher augmentation of the plant or through additional processes ought to be attained to trim down desired areas. The water hyacinth-based system has shown great promise as a low-cost and efficient water purifier, and its relevance is mounting worldwide.

Initially, it was only used for sewage treatment and now is used in treatment of a broad range of chemical substances. Nowadays, it is a great contributor to the solution of numerous desires akin to raw material for various industries, especially for the rustic poor, milieu protection energy, water furnishing, and fertilizer. The full potential of this plant is yet to be tapped.

9.10 New Technology in Water Handling

According to the most recent third world Academy of Sciences report, of the six billion inhabitants on the globe, in excess of one billion (one in six) do not have access to safe drinking water, and 2.5 billion (more than one in three) do not have access to satisfactory sanitation sources. Today, 31 countries representing 2.8 billion inhabitants, including India, Nigeria, China, Ethiopia, Peru, and Kenya, confront unremitting water problems. Within a generation, the population of the earth will be close to eight billion people, yet the amount of water will be the same. Therefore, we have to discover newer, better ways to treat, recycle, and save the water.

New Approaches

1. Shielding accessible water resources and inventing effectual ways to trim down water utilization for different human uses.
2. New affordable reverse osmosis for desalination.
3. Recycle akin to the gray water that can be used to recharge groundwater to assist in curtailing the salinity levels and to improve the health of swampland.
4. Effective water harvesting.

Method Forward

The new treatment processes for resource revival along with the toting up of metropolitan water and waste management methods will help develop the sustainability of our water resources. The new technologies can significantly lessen water abstraction from our resource constrained world. Retrieving water must be managed suitably to sustain the integrity of the overall treatment system. The vigor utilization in treatment plants also requires active administration to make the complete process efficient and effective. Technologies to meet this challenge before now subsist and work is going on to transform and incorporate them into superior performing, more sustainable systems. The challenges are choosing the appropriate one from the obtainable options and emergent institutional planning for executing them in the most efficient ways.

9.11 Conclusion

Presently, financial crunch in numerous urbanized and developing nations is forcing the execution of low-cost natural and green technological treatment systems for domestic and industrial wastewater solutions. When the technical treatment amenities are installed in many developing countries, the force input is complicated to supply in view of the worldwide energy emergency and its affordability is questionable due to very high outfitting costs. These factors are spurring the employment of environmental engineering ethics for not only misuse solutions but also for conserving biological communities in deprived nations of the globe.

Over the past two decades, ecological regulations have become more stringent, requiring an enhanced quality of manufacturing wastewater effluent. The great number of studies reviewed here is indicative of the extensive and intense investigation that has been done in the field of manufacturing wastewater solutions. These studies cover a broad range of manufacturing pollutants, a broad range of solution technologies, and model solutions with entity substances in genuine effluents containing a combination of diverse importunate substances.

The selection of the most appropriate treatment for industrial wastewater depends primarily on its characteristics and on numerous other parameters, such as ease of use and testing of the technology, pollution control, environmental impact, the overall recital, plant simplicity, experience technologies, and economic parameters, including the capital investment and operational costs. Although a systematic modus operandi exists consisting of model substances prior to stuffing the authentic wastewater, and appraises toxicity and biodegradability throughout and after the degradation process, more pilot-plant scale trials with real industrial wastewater must be executed on a larger scale.

The innovative incorporated technologies entail appraising the absolute wastewater treatment in sequence to be reused in the industry itself. Auspiciously, a lot of technology to meet these demands already exists, and effort is being done to sanitize and incorporate them into the higher theater of further sustainable systems. These are all vicinities in which engineers excel. The companion challenge will be choosing amongst the accessible options and developing institutional planning for putting them into operation in the most effective ways.

This is where we will require aid from other vocations. Permutations and intergradations of a technology were able to treat a broad assortment of high potency and noxious industrials. Such intergradations of treatment technologies can shift the exemplar of wastewater management from treatment and discarding to beneficial consumption and lucrative endeavors.

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