Effects of microorganisms on nitrogen and phosphorus removal from wastewater

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Abstract. Nitrogen and phosphorus are key to plant growth. The balance of nitrogen and phosphorus is crucial in nature. Excessive nitrogen and phosphorus content in wastewater has caused great harm to the environment. Traditional nitrogen and phosphorus removal methods can no longer meet the treatment standards for nitrogen and phosphorus. This article introduces the hazards of nitrogen and phosphorus, and points out the harm to nature and human beings if they are not up to standard in wastewater treatment plants. Through the analysis and discussion of several methods, the advantages of microbial nitrogen and phosphorus removal are explained. This article further summarizes several representative new microorganisms and microbial processes through the types and mechanisms of microbial nitrogen and phosphorus removal. Anammox bacteria can accept other electron pools to increase nitrogen removal efficiency. Denitrifying phosphorus-removing bacteria can achieve energy saving and carbon reducing effects through endogenous denitrification. Besides, the enhanced biological phosphorus removal process can allow denitrifying phosphorus accumulating bacteria to absorb phosphorus in an anaerobic, anoxic, aerobic alternating environment. The moving bed biofilm reactor (MBBR) abandons the disadvantages of the traditional biofilm method, while retaining the advantages of the traditional biofilm method such as shock load resistance and low sludge production. These new microorganisms and new microbial processes have become important applications in future nitrogen and phosphorus removal processes due to their advantages of high efficiency, low energy, and no secondary pollution. This article is conducive to the promotion of microbial-based wastewater treatment and can provide suggestions for the sustainable development of wastewater treatment.

Keywords: Nitrogen, Phosphorus, Wastewater, Microorganisms.

1. Introduction

With increasing global economic, energy and environmental requirements, many wastewater treatment plants face complex and urgent challenges. In dealing with nitrogen and phosphorus, the energy consumption of wastewater treatment plants is very large, so that the investment cost is not directly proportional to the operation efficiency. For example, the power consumption of lifting pump stations, aeration equipment, sludge thickeners, and the energy loss in the sludge treatment stage are the largest. They have the highest costs as well. The treated wastewater will produce a large amount of excess sludge as well, which will carry part of the water flow and cause water flow loss. At present, human

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input of excessive nitrogen and phosphorus into the environment. Nitrogen inputs are transforming originally nitrogen-limited ecosystems into nitrogen-saturated states, accompanied by the loss of large amounts of nitrogen in aquatic ecosystems. Additionally, some models suggest that lots of tropical plants use phosphorus as their main source of nutrients, because nitrogen is already oversaturated and difficult to enrich and absorb. Excessive nitrogen will affect the phosphorus recycling system, making it difficult for plants to absorb nutrients [1]. Therefore, man-made input of excessive nitrogen and phosphorus into nature, will lead to a severe damage to the natural ecosystem.

Studies have shown that wastewater treatment are extremely important to lake eutrophication. When the denitrification and phosphorus removal efficiencies are maintained at a high level, the more stable the ratio of nitrogen and phosphorus in the water body is, the closer it is to the natural concentration, and the lower the degree of eutrophication of the lake. So wastewater treatment of nitrogen and phosphorus is crucial [2]. Today, most wastewater treatment plants still rely on the traditional activated sludge process to treat wastewater. This method mainly focuses on the removal of organic pollutants and suspended solids, with limited treatment effects on nitrogen and phosphorus. There are also some wastewater treatment processes that use physical, chemical and other methods to remove nitrogen and phosphorus. However, these methods require the purchase of a large amount of medicaments, which are expensive, easily cause secondary pollution. With the improvement of water ecological protection and water control standards, the upgrading of wastewater treatment plants is the general trend. At present, we need to devote ourselves to developing technologies suitable for simultaneous biological nitrogen and phosphorus removal in secondary effluent, such as exploring the special biological effects of microorganisms on nitrogen and phosphorus, and combining several processes [3]. This method does not require a large amount of chemicals, thereby effectively reducing the risk of secondary pollution and energy loss during wastewater treatment. By minimizing the nitrogen and phosphorus loads in the environment, it can effectively prevent the eutrophication of water bodies, ensure the sustainable use of water resources and ecological balance, and help build a conservation-oriented and sustainable development society.

In the above case, this article aims to elucidate the applicability and efficiency of microorganisms for denitrification and phosphorus removal. This paper analyzes the advantages of microbial methods by comparing the commonly methods. Through the in-depth analysis of actual cases, the practical application effect of microbial method in wastewater treatment is demonstrated. Finally, by analyzing the key role of microbial methods in sustainable development, useful guidance and suggestions are provided for the sustainable development of effluent treatment plants. Through research and discussion, this article hopes to comprehensively promote the application of microbial methods in the field of water treatment, inject sustainable power into the development of the industry, and provide constructive guidance for relevant practitioners.

2. The effects of excess nitrogen and phosphorus

2.1. Main sources of nitrogen and phosphorus

In nature, nitrogen mainly comes from nitrate produced by lightning and ammonia nitrogen produced by animal decomposition, and phosphorus mainly comes from the dissolution of minerals by rainwater and phosphorus contained in animal manure. The nitrogen and phosphorus content in nature can well maintain the balance of the water environment without destroying the food chain and biodiversity in the water. However, with the intensification of human activities, excessive nitrogen and phosphorus pollutants are contained in domestic sewage, agricultural wastewater, and industrial wastewater, causing serious pollution to water bodies. Human beings and the environment influence each other and develop together. Water pollution will inevitably affect human health as well.

Nitrogen and phosphorus in domestic sewage mainly come from people's food residues, phosphorus-containing laundry, and cosmetics. During the microbial decomposition of food residues, ammonia nitrogen will be released. Food residues will be discharged into the sewers along with domestic sewage, causing a large amount of ammonia nitrogen to exist in the drainage system. In agricultural irrigation, pesticides and fertilizers containing nitrogen and phosphorus are often used. Excess nitrogen and phosphorus cannot be absorbed by crops, but are discharged into water bodies along with agricultural wastewater after farmland irrigation. In addition, the factory produces large amounts of wastewater containing nitrogen and phosphorus, which is very harmful.

2.2. The hazards of excess nitrogen and phosphorus

Reactive nitrogen in wastewater flows into receiving water bodies in large quantities, causing a series of environmental problems: such as eutrophication of water bodies and the proliferation of toxic algae. Nitrogen and phosphorus are needed for plant growth. If the treated water with excessive nitrogen and phosphorus is directly discharged into rivers, lakes, reservoirs and other waters, algae in the water will grow wildly and quickly occupy the entire water area. This will produce algae blooms, causing water turbidity and deterioration. This will further lead to low dissolved oxygen content in the water and the production of toxic and harmful substances in the water, causing the death of a large number of fish and shrimps and other aquatic animals, thereby reducing biodiversity.

In addition, the discharge of reactive nitrogen into the environment can also cause serious groundwater pollution. Nitrogen-containing wastewater seeps into the ground, polluting the groundwater. Groundwater is part of the drinking water source. If its nitrogen concentration exceeds the standard, it will be very harmful to human health. When the nitrite content in water is high, nitrite will combine with proteins in the human body to form nitrite amines, thus greatly increasing the risk of cancer.

Excessive nitrogen content in water can also cause global warming. When water evaporates, excess nitrogen in the water will evaporate with it to form atmospheric reactive nitrogen, which will not only cause damage to the human respiratory system, but also cause smog and acid rain, destroy the ozone layer, and exacerbate global warming. Human activities have changed the nitrogen and phosphorus cycles in nature, so we must work to reduce the negative impacts of human activities [4].

3. Analysis of Nitrogen and Phosphorus Removal Methods

3.1. Classification and Comparison of methods for nitrogen and phosphorus removal

At present, the methods for treating nitrogen and phosphorus in wastewater include physical, chemical and biological denitrification methods. Chemical denitrification methods mainly include chemical precipitation and breakpoint chlorination methods. Chemical reagents need to be added during the treatment process, which can easily cause secondary pollution. Physical denitrification methods mainly include ion exchange and blow-off methods, which require constant adjustment of pH, temperature, and continuous changes in phase state. They also require large mechanical power equipment to operate, which consumes a lot of energy and requires complicated manual management. The process of biological denitrification includes nitrification-denitrification, short-cut nitrification-denitrification and anammox. It does not need chemicals or large-scale mechanical equipment. It has the advantages of economy, high efficiency and no secondary pollution, which is conducive to sustainable development. It has been increasingly adopted in recent years [5].

In wastewater treatment plants, activated sludge method is often used to treat wastewater. The activated sludge method mainly uses the biological function of sludge. In an aerobic environment, microorganisms on sludge can remove dissolved and colloidal biodegradable organic pollutants and some suspended solids in wastewater. However, this method does not have microorganisms for removing nitrogen and phosphorus, so its effect on treating nitrogen and phosphorus in wastewater is very weak. If the nitrogen and phosphorus content in the wastewater is high, the traditional activated sludge method cannot effectively remove the nitrogen and phosphorus. Eventually, wastewater discharged into water bodies will lead to eutrophication of water bodies and environmental pollution.

With the increasing pollution of environmental water bodies and the advancement of technology, many effective wastewater treatment processes against the nitrogen and phosphorus removal have gradually been derived. For example, the oxidation ditch process mainly utilizes the uneven distribution

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of dissolved oxygen in the ditch, so that aerobic and anoxic regions are alternately cycled in the ditch for denitrification. However, the phosphorus removal effect of this process is very small. It is difficult to ensure that microorganisms are in optimal growth conditions in both the aerobic zone and the anoxic zone, so the treatment effect is limited. In the anaerobic Oxic (A/O) process, the nitrate in the reflux liquid gets sufficient nutrients from the organic pollutants of the original wastewater in the anoxic tank to achieve the effect of nitrogen removal. However, because there is always a part of the flow in the aerobic tank that cannot return to the anoxic tank, the carbon source in the anoxic tank gradually decreases, and the denitrification reaction gradually weakens. As time goes by, the removal of two elements effect decreases. Anaerobic-Anoxic-Oxic ($A^{2/}O$) process simultaneously removes nitrogen and phosphorus through three stages: anaerobic, anoxic and aerobic. This process requires a higher mixed liquid reflux ratio to ensure denitrification. At the same time, nitrifying bacteria, denitrifying bacteria, and phosphorus accumulating bacteria are competing for limited and gradually decreasing demand for organic matter and carbon sources. Therefore, it is difficult to achieve efficient removal of nitrogen and phosphorus simultaneously in this process.

In view of the limitations of the current more traditional nitrogen and phosphorus removal processes, it is necessary to explore a new microbial treatment method and find targeted microorganisms that specifically remove nitrogen and phosphorus. Based on this method, we can achieve efficient and simultaneous removal effect.

3.2. Advantages of microorganisms in the treatment of nitrogen and phosphorus in wastewater

Physics methods often require large amounts of energy. The mechanical equipment used in the physical method occupies a large area, making manual management complicated. In addition, the physical removal method requires frequent maintenance and high economic costs, which does not meet the current requirements of low energy consumption, energy saving and emission reduction. The chemical method requires the addition of a large amount of additional chemicals, which is expensive and prone to secondary pollution. It does not meet the requirements of protecting the environment as its main purpose. Biological method can not only effectively avoid secondary pollution caused by excessive use of chemicals in wastewater treatment, but also has extremely low energy consumption. This helps to promote the development of wastewater treatment processes in the sustainable direction of low energy consumption, efficient nitrogen and phosphorus removal, reduction of residual sludge, reduction of pollution, easy operation, and convenient management. More importantly, biological method helps achieve phosphorus recovery and water reuse, achieving secondary use of energy.

1) Economic Advantages of Microbial Treatment

When using microorganisms to treat wastewater, in addition to microbial strains, simple chemicals such as acid-base neutralizers, carbon sources need to be added to create a good growth environment for microorganisms. In addition, the main equipment costs of the microbial method include microbial aeration devices, wastewater sludge return devices, and sludge disposal devices. Compared with physical and chemical methods, microorganisms, as natural substances, have good adsorption, sedimentation and degradation capabilities. It can operate efficiently only by adding a small amount of chemicals. No other physical pressure, lots of chemicals are required, so the treatment cost is lower. Therefore, the challenge of using microbial methods is to cultivate microorganisms. Once the microorganisms grow stably and continue to function, they will produce huge economic benefits.

2) Energy Efficiency Advantages of Microbial Treatment

Microorganisms can eliminate viruses, pathogenic bacteria, fungi and other substances that are toxic to the human body in wastewater by adsorption and phagocytosis. Microorganisms oxidize toxic and harmful substances in wastewater and adsorb them on the sludge. After the sludge undergoes sludge digestion and other treatments, it becomes non-toxic and harmless substances. Microorganisms can also absorb, degrade, and precipitate colloidal impurities in wastewater to reduce the color of water and improve the transparency of water. We can see that biological methods can treat water pollutants through the biological effects of microorganisms and bacteria without the need for mechanical or chemical

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treatment. This special mechanism enables microbial methods to achieve energy conservation and emission reduction while maintaining high efficiency in nitrogen and phosphorus removal.

3) Environmental Advantages of Microbial Treatment

Microorganisms can degrade organic pollutants in wastewater into non-toxic and harmless gases and substances such as water, carbon dioxide, nitrogen, and sludge, with minimal pollution and impact on the environment. The sludge produced by microorganisms can also be recycled and reused through sludge concentration, anaerobic digestion, sludge incineration, sludge composting, which is conducive to achieving "carbon peaking and carbon neutrality" and building a sustainable green society.

3.3. Bacteria types and action mechanism of nitrogen and phosphorus removal microorganisms

3.3.1. Ammonifiers and ammonification reactions. There are two types of ammonia denitrification bacteria, aerobic and anaerobic. In the biological denitrification process of wastewater treatment, the nitrogen-containing organic matter in the wastewater is oxidized and decomposed into free ammonia nitrogen by ammonifying denitrification bacteria, so that the original polluted organic matter can be denitrified. Ammonia denitrification bacteria can degrade nitrogen-containing organic matter into simple nitrogen-containing compounds such as amino acids and polypeptides under aerobic or anaerobic conditions. Then they will convert simple nitrogen-containing compounds into NH3-N. This reaction of removing nitrogen is called amination reaction.

3.3.2. Nitrifying Bacteria and Nitrification Reaction. Nitrifying bacteria are a type of aerobic bacteria, most of which are autotrophic and include Nitrosomus and Nitrobacter. The genus Nitrosomus is called ammonia-oxidizing bacteria (AOB). AOB gains energy by catabolizing unionized ammonia into nitrite. Its function is to convert ammonia nitrogen into nitrite nitrogen, that is, NH_4^+-N→NO_2^--N. Nitrobacter is called nitrite-oxidizing bacteria (NOB). Its function is to convert nitrite nitrogen into nitrate nitrogen, namely NO_2^--N→NO_3^--N. The two bacterial communities provide themselves with the energy needed for production and metabolism through the oxidative decomposition of nitrogen. They rely on each other to complete the nitrification reaction and control the level of nitrogen. Thet are significant to the nitrogen cycle in nature. They are also a major contributor to biological denitrification in wastewater treatment. In addition, researchers also discovered a type of ammonia-oxidizing archaea (AOA). These archaea also the major bacteria in the removal of nitrogenous wastes [6].

Another type of bacteria is anaerobic ammonium oxidizing bacteria, which belong to the Planctomycetes species. They are autotrophic bacteria that show a unique red color and usually grow under hypoxic conditions. Anaerobic ammonium oxidizing bacteria use carbonate or carbon dioxide as the carbon source, ammonia as the electron community, and nitrite as the electron acceptor to convert NH_4^+ and NO_2^--N into N_2.

This type of bacteria can eliminate intermediate steps and directly convert ammonia nitrogen in wastewater into nitrogen gas for removal. This type of bacteria can eliminate intermediate steps and directly convert ammonia nitrogen in wastewater into nitrogen gas for removal. However, anaerobic ammonium oxidizing bacteria currently have problems such as difficulty in isolation, difficulty in enrichment, and low concentration of nitrite in wastewater. Researchers are still conducting further research and have not widely used it in wastewater treatment plants.

3.3.3. Denitrifying Bacteria and Denitrification Reaction. Most denitrifying bacteria are facultative heterotrophic bacteria, which generally grow and reproduce under anoxic or low oxygen conditions. Denitrifying bacteria can gradually reduce nitrate nitrogen (NO_3^-) to N_2 and release it into the atmosphere to complete denitrification, allowing the nitrogen-containing organic matter in the wastewater to completely leave the liquid and be removed.

Nitrifying bacteria and denitrifying bacteria work together to convert ammonia nitrogen into nitrogen gas. This reaction system requires strict control of the oxygen content in different areas. Without proper control, it will be difficult to remove ammonia nitrogen efficiently. In recent years,

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researchers have discovered aerobic denitrifying bacteria, which can perform denitrification under aerobic conditions, avoiding the complex control process of oxygen environment during the denitrification process. Aerobic denitrifying bacteria mainly exist in the genus Pseudomonas, Alcaligenes, Paracoccus and Bacillus. It is an aerobic or facultative anaerobic heterotrophic nitrifying bacteria that uses the action of denitrifying mold to carry out nitrification reaction under aerobic conditions. Its main product is N_2O.

3.3.4. Polyphosphate Bacteria and Phosphorus Removal Mechanism. Phosphorus accumulating bacteria play different roles under aerobic and anaerobic conditions. Under aerobic conditions, this kind of bacteria use oxygen as electron-accepting substance and reduced substance to oxidize the energy storage in the cell, absorb dissolved $PO4^{3-}$-P from wastewater, and synthesize phosphate within the cell. Under anaerobic conditions, phosphorus accumulating bacteria consume organic matter in wastewater and store them in the body as a nutrient source. The bacterium hydrolyzes the polyphosphate in the cell into $PO4^{3-}$-P and releases it to the outside of the cell. Energy is then obtained from the release process for cell growth and metabolism. Under anaerobic conditions, phosphorus-accumulating bacteria can re-release phosphorus. In sludge treatment, this characteristic of phosphorus-accumulating bacteria can be used to recycle phosphorus.

In conclusion, phosphorous accumulating bacteria play different roles in aerobic and anaerobic conditions to promote their growth, remove phosphorus from wastewater, and recycle phosphorus.

4. Practical Application

4.1. Advantages of microorganisms in the treatment of nitrogen and phosphorus in wastewater

Anaerobic ammonium-oxidizing (anammox) bacteria play the vital role in the biological nitrogen cycle and have been gradually used to efficiently remove inorganic nitrogen from ammonium-rich wastewater. It can directly convert ammonium ion and nitrite ion into nitrogen, which provides a shortcut for the nitrogen cycle and a sustainable solution for the application of nitrification-denitrification processes. For example, using anaerobic ammonium oxidizing bacteria to combine reaction steps can achieve lower aeration costs, lower biomass production, lower greenhouse gas emissions [7].

At the same time, because anaerobic ammonium oxidizing bacteria are sustainable in wastewater treatment, they have the advantages of low oxygen consumption or even no need for oxygen, no need for carbon source enhancement, and no CO_2 emissions. In addition, the good tolerance of anaerobic ammonium oxidizing bacteria to organic waste, temperature and other pollutants is also a major reason why they are popular in wastewater treatment [8].

In the above, we learned that there are some problems with anaerobic ammonium oxidizing bacteria (anammox bacteria), that is, wastewater does not often contain nitrite, which has certain limitations in its application. However, in recent years, researchers have discovered that in addition to nitrite, anammox bacteria can couple anammox to its respiratory chain through other electron acceptors, such as sulfate, BES electrode (anodic anammox oxidation), nitric oxide, organic acids, Mn (IV), Fe (III), amines. They can also support ammonium oxidation by anammox bacteria under anaerobic conditions. In this way can avoid the problems of small number of receptors and low nitrogen conversion rate of anammox bacteria in wastewater. The removal efficiency of ammonia in wastewater is increased as well. Therefore, in recent years, many emerging research methods have emerged using anammox bacteria for nitrogen removal. For example, anaerobic ammonium oxidation Microbial fuel cells (MFC) in bioelectrochemical systems combined with anaerobic ammonium oxidation processes can be used for simultaneous denitrification and power generation. The Microbial electrolysis cells (ME) process combines single-chamber microbial cells containing anode and cathode electrodes enriched with nitrifying and denitrifying biofilms with an anaerobic ammonium oxide process to assess the impact of low-pressure application on nitrogen removal rates. Although the above researches are only initially applied in practice and have great limitations, new breakthroughs and new methods can save a lot of manpower and financial resources, and are more environmentally friendly and efficient. They are undoubtedly a highly economical technology worthy of research and development [9].

4.2. Application of Denitrifying phosphorus removal in wastewater treatment

In an anaerobic and anoxic alternating operating environment, it is necessary to enrich facultative anaerobic microorganisms with denitrification and phosphorus removal functions, such as denitrifying phosphate-accumulating organisms (DNPAOs). This microorganism uses NO^{3-} as an electron acceptor to metabolize and simultaneously perform denitrifying phosphorus removal processes. Under anaerobic conditions, DNPAOs absorb carbon substrates from the outside in a similar manner to phosphate-accumulating bacteria and store them in the cells in the form of polyhydroxyalkanoates (PHA). Under hypoxic conditions, it can utilize nitrite or nitrate instead of oxygen as electronic recipients to take effect without any extracellular carbon substrate [10]. Compared with other phosphorus removal methods, denitrifying phosphorus removal can save a lot of carbon sources, COD and O_2. The remaining sludge can be reduced by about 50%, which can simultaneously achieve the goal of energy saving and carbon reduction.

When organic matter is scarce in the environment, microorganisms can denitrify by consuming their own living substances, which is called endogenous denitrification, and generate NH_3 and N_2. At present, some researchers have found that endogenous partial denitrifying phosphorus removal (EPDPR) can achieve stable nitrite accumulation and phosphorus removal. Therefore, the new process that combines endogenous partial denitrification phosphorus removal (DPR) can get the high-concentration removal of nitrate and phosphorus in an anaerobic/anoxic/aerobic sequential batch reactor (SBR) [11].

In addition, Enhanced biological phosphorus removal (EBPR) is a technology that can simultaneously and efficiently remove phosphorus on the basis of nitrogen removal. As a result, the process minimizes sludge and reduces the need for carbon sources [12]. Polyphosphate accumulating organisms (PAOs) are capable of storing phosphorus under conditions of anaerobic and aerobic cycling. Carbon sources are absorbed anaerobically and stored as polyhydroxy fatty acids (PHA) by releasing phosphorus and degrading glycogen. After PHA is oxidized, it provides electron acceptors for PAOs (usually oxygen is used as the electron acceptor, and in hypoxic conditions, nitrate and nitrite can also be available). With the growth of organisms and glycogen regeneration, PAOs can be absorbed more phosphorus. This process makes full use of microorganisms with different properties and multiple functions. It can absorb phosphorus in wastewater under an alternating aerobic environment. It is green, efficient, and has broad development prospects.

4.3. Representative biological treatment process MBRR

The moving bed biofilm reactor (MBBR) is a novel type of cost-effective continuous flow biofilm reactor. The MBBR has a small footprint and is easy to install, control and operate. In the temperature range of 1-21°C, MBBR has a significant removal effect on ammonia in wastewater.

The main principle of the reactor is to use the wastewater to continuously flow through the MBBR filler carrier to form a layer of biofilm on the carrier, so that microorganisms can multiply on the biofilm. A large number of microorganisms degrade the organic pollutants and nitrogen concentration in the wastewater, thereby purifying the wastewater. The MBBR process overcomes many disadvantages of solid bed reactors, such as the need for regular backwashing, the regular cleaning of filter media due to frequent blockage of submerged biological filters and the need for frequently replacing aerators. At the same time, it retains the impact load resistance and low sludge yield of the traditional biofilm method. It is worth noting that the sludge yield of MBBR is the lowest, which is 90% lower than that of traditional sewage treatment plant processes, and the sludge age is longer.

Relying on the characteristics of its long clay age, MBBR can retain nitrifying bacteria for a long time, keeping the nitrifying bacteria in a high concentration state. In addition, MBBR does not often add new nitrifying bacteria, which has lower cost. Installing MBBR upstream of wastewater treatment plants with low C/N will reduce the impact of organic matter on nitrifying bacteria and increase the

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nitrification rate. MBBR systems do not require backwashing. It can improve its processing capacity by increasing the percentage of biological carrier filling [13].

5. Sustainable development of microbial nitrogen and phosphorus removal

Research shows that microbial technology can contribute to green energy production at a higher level. Because most of the microbial biofilms have adsorption and flocculation effects, they are often used in various water treatment systems.

Wastewater treatment plants use microbial treatment methods to remove nitrogen and phosphorus from wastewater, which not only solves the problems of low efficiency in treating wastewater, substandard water quality, large amounts of residual sludge that is difficult to process, but also makes the operation and management of wastewater treatment plants more efficient. convenient. The use of biological methods to treat wastewater has also been fully recycled in terms of energy. For example, phosphorus in wastewater is absorbed by phosphorus accumulating bacteria under aerobic conditions. When the remaining sludge is to be treated, it can release phosphorus under anaerobic conditions, so that phosphorus can be recycled and reused. With the emergence of more and more new bacterial strains and new processes, the performance of the original organisms has been improved and enhanced, the energy consumption of the process has been continuously reduced, and the remaining sludge has been gradually reduced. Microbial removal method is developing in the direction of continuous progress and widespread use.

Microorganisms use their unique biological effects to remove nitrogen and phosphorus from wastewater treatment plants through a series of self-reactions. Microorganisms do not produce toxic or harmful substances and do not cause secondary pollution to the surrounding environment and water bodies. It is a green and sustainable treatment method. As human activities have an increasingly serious impact on the environment, we should explore and develop green and sustainable technologies and energy to minimize the pollution of environmental water bodies caused by substandard wastewater treatment.

In conclusion, given the increasing consumption of non-renewable energy, deteriorating global climate quality, and increasing carbon emissions, finding and achieving means for sustainable development and a cleaner environment has become an urgent task. Microorganisms can make significant contributions to mitigating climate change, improving green production technologies, and increasing crop productivity. Green microbial technology helps assist to achieve the directions of cleaner production technology, furthering develops sustainable goals [14].

6. Conclusion

This article analyzes the necessity and urgency of nitrogen and phosphorus treatment in wastewater by explaining the main sources of two elements in wastewater, and the harm caused by discharging wastewater into water bodies when the concentration of nitrogen and phosphorus in wastewater is not up to standard. In the natural environment, when they are in excess, aquatic plants absorb nitrogen and phosphorus, and then crazily occupy the entire water area, leading to serious algae blooms. Its infringement range is wide, seriously affecting the ecological balance and affecting biodiversity. Subsequently, the article introduces methods for treating them in wastewater. By comparing the advantages and disadvantages of physical, chemical, and biological methods, the article focuses on the environmental protection, high efficiency, and sustainable development advantages of biological methods in nitrogen and phosphorus treatment. Furthermore, the article advocates the use of new microbial communities removing the nitrogen and phosphorus, that is, the use of various non-toxic, harmless and pollution-free microorganisms and new technologies. Then, this paper introduces the process and mechanism by different strains, reveals that the three strains of ammonification, nitrification and denitrification complete the denitrification process together, and the strains with phosphorus accumulating bacteria as the main phosphorus removal complete the phosphorus removal process. In addition, the article briefly introduces several typical new strains and new biological denitrifying phosphorus removal processes with relevant research results. These new types of research and design represent that microbial treatment in wastewater has been recognized by the public and is constantly being developed and improved.

Although the microbial community nitrogen and phosphorus removal technology has initially established a relatively mature process, traditional biological treatment still has problems such as difficult biological enrichment and limited removal efficiency. However, due to its powerful advantages of energy saving and no secondary pollution, microbial community nitrogen and phosphorus removal has great research value. According to the existing research results and ongoing research content, it is expected to discover and confirm more microorganisms with efficient nitrogen and phosphorus removal functions in the future, create and design more new biological treatment technologies to make wastewater treatment plants develop in the direction of being more efficient, energy-saving, recyclable and artificial power reducing.

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