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MICROBIAL MARVELS: REVOLUTIONIZING WATER POLLUTION TREATMENT IN URBAN ENVIRONMENTS

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Abstract

The escalating pace of industrialization in urban centers has triggered growing apprehensions regarding the pervasive environmental threat posed by water pollution. This concern resonates across society, urging a concerted effort towards effective mitigation strategies. Microbial detection technology emerges as a pivotal player in the ongoing battle against water pollution, demonstrating its widespread application and significant impact on environmental remediation. Microorganisms, with their unique capabilities, offer a promising avenue for resource optimization in treating environmental issues, thereby presenting a viable solution to the pressing problem of pollution. This paper delves into a comprehensive exploration of the various types of water pollution and elucidates the intricate mechanisms underlying microbial technology. A comparative analysis with traditional physical and chemical treatment techniques underscores the manifold advantages that microbial technology holds in sewage treatment. The study seeks to unravel the potential of microbial intervention as a transformative force in environmental conservation.

Introduction

With the advance of industrialization in urban cities, the harm of water pollution to the environment has become a widespread concern to the people of the whole society. Microbial detection technology has been widely applied and played a significant role in water pollution treatment. Microorganisms could improve the utilization of resources in environment treatment so as to effectively solve the problem of environmental pollution. Microbial technology has many advantages in sewage treatment compared with traditional physical and chemical treatment techniques. In this paper, we conduct research on the main types of water pollution and the mechanism of microbial technology.

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Main Types of Water Pollution

Water Pollution in Agricultural Production

Water resources are important material resources in agricultural production. In water used in agricultural production, water resources mainly come from groundwater, lakes, rivers, and rainwater. During the development procedure of scale production and mechanization in agriculture, the demand for water resources also continues to increase. However, according to the current production status, in order to improve the production efficiency and meet the nutritional needs of crop growth, some growers use chemical fertilizers and pesticides without control, which contain a large amount of nitrogen, phosphorus, and potassium. If the used amount exceeds the soil's carrying capacity, those chemical fertilizers and pesticides would flow into the nearby water along with the rainfall or runoff, and thus cause pollution of water resources. Currently, in China's rural areas, agricultural production has become an important factor of water pollution.[1]

Water Pollution in Livestock Production

With the continuous improvement of Chinese residents' living standards, the market demand for livestock products continues to increase, leading to the intensification of the industry as well as the production in large scale. Despite that there are certain differences in the demand for water resources between livestock breeding and agricultural production, the livestock production still needs a certain amount of water resources as a support, such as livestock and poultry drinking water, enclosure washing, etc. Affected by the past solidified production mode, fecal waste of livestock and poultry production could not be properly treated. Moreover, in order to save farming costs, some farmers would not treat fecal wastes in a centralized way. Instead, they randomly piled up those wastes in the nearby environment or directly discharged them into the local water body, causing pollution to the water environment.[2]

Water Pollution in Residents Living

Residents are more dependent on water resources in their lives, such as daily drinking water, washing vegetables, cooking, washing, etc. With the increase in the number of residents in China, the amount of water used in life also continues to increase. At the same time, the sewage resulting from those water would have a great impact on the ecological environment without scientific treatment. For example, in some small cities, the amount of domestic sewage continues to increase. Meanwhile, the urban infrastructure is not in place. In addition, the sewage treatment plant suffers from insufficient capacity and lagging technology. If the sewage is directly discharged into the rivers and lakes without thorough purification, it would cause environmental pollution in the long term. Moreover, living sewage also contains a large number of pathogenic bacteria, and provides an opportunity for spreading disease.[3]

Water Pollution in Industrial Production

The industry is the foundation of our country. Since the beginning of the founding of New China, China's industrial system has continued improving and the industrial development process has continued accelerating. However, due to the effect of the fixed concept and the traditional mode, industrial production would produce a large amount of industrial wastewater. In the past, industrial wastewater is usually discharged directly into the nearby waters without any treatment, causing pollution to the waters. With the increase of China's government control, the situation of private discharge has been effectively controlled, but this situation still exists in some remote areas. The content of industrial wastewater is comparatively complex. For example, heavy metals are the main components of industrial wastewater, which is more harmful. It would remain in the water and animals. More seriously, if humans take these as food for a long time, their health would be jeopardized.

1. Overview of Microbial Technology in Environment Treatment of Water Pollution

1.1 Meaning of Microbial Technology

Microbial technology mainly refers to that the microorganisms existing in the sewage could decompose and oxidize organic matter through reproduction, growth, and redox reaction, and transform harmful and toxic substances into harmless and non-toxic organic matter, so as to play a role in sewage treatment.[4] In other words, microbial technology aims to build an environment conducive to the growth and reproduction of microorganisms through physical and chemical methods. In this way, we could give full play to the role of microorganisms in the oxidation and decomposition of organic matter, so as to eliminate bacteria and fungi in sewage.

Mechanism of Microbial Technology

Degradation

Degradation is one of the most intuitive roles microorganisms played in dealing with environmental wastewater. In terms of the needs of microorganisms at the biological level, their reproduction and activities need to obtain energy from organic matter. Water eutrophication means that there is a large amount of organic matter in the water, so microorganisms would continue to react with the organic matter in the water after being applied in environmental wastewater treatment. By absorbing energy from those reactions and further degrading into inorganic matter, those microorganisms could constitute a unique cyclic state in sewage and achieve a balance in the sewage environment. (As shown in figure 1)

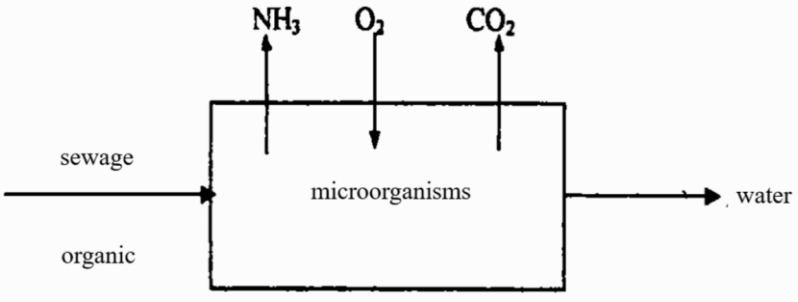

Figure 1. Degradation mechanism of microorganisms[5]

1.1.1 Detoxification

Sewage shows a certain degree of toxicity because of a large number of pollutants in the water. Social events related to environmental sewage are also caused by the biological toxicity of sewage which exceeds the standard, making the toxicity of the water an important reference index in the current wastewater discharge. Only when the toxicity of the sewage is below a certain level, it would not have a negative impact on the biology. Hence, sewage would be allowed to be discharged only when it would just cause a minor negative impact on the environment. Researchers have found that the technology has a certain detoxification effect on the sewage. Such detoxification is first reflected in the purification of inorganic phosphorus in the water. Therefore, we should reasonably apply microbial technology to urban wastewater treatment so as to achieve in depth purification of the inorganic phosphorus in the sewage. As a result, the requirements of wastewater discharge could be met and the negative impact on the ecological environment would be better controlled.

1.1.2 Metabolism

Metabolism is the ability of microorganisms themselves, meaning that the microorganisms could obtain the corresponding energy from the organic substances in sewage, and then use them into microbial reproduction and metabolism. This process involves a variety of pollutants in the sewage, resulting in a series of relatively complex chemical reactions.

A large number of substances in pollutants would be used as raw materials for chemical reactions. After these substances are consumed, the pollution level of the sewage will plummet. The metabolism of microorganisms is generally realized through various strains of bacteria, such as actinomycetes, bacilli, etc. Microorganisms could have a favorable metabolic effect on the fat in the water. Besides, the products of microbial metabolism may be reacted with other pollutants in the wastewater, thus significantly reducing the possibility of secondary pollution.

Application of Microbial Technology in Environment Treatment of Water Pollution

Microbial Adsorption Technology

Microbial adsorption technology is to form a relatively stable solid material by combining some substances in the sewage and some substances in microorganisms themselves or substances with certain physical and chemical properties produced from microbial physiological metabolism, and then to separate solid materials in the sewage by utilizing some manual techniques. Microbial adsorption technology is a relatively new way in the microbial treatment of wastewater, boasting the advantage of low cost. At present, it has been widely used in the treatment of heavy metal wastewater with a certain area of pollution. Related studies have found that adsorbing heavy metal ions in sewage by using microbial adsorption technology would only take several hours to get a relatively obvious effect. Moreover, with the prolongation of adsorption time, the adsorption effect will be much better. However, with the prolongation of adsorption time, microbial metabolism will gradually reduce the activity of microbial physiological metabolism. Therefore, in the practical application, we need to determine a reasonable adsorption time by striking a trade-off between the adsorption time and the activity degree of microbial physiological metabolism.

1.2 Microbial Flocculation Technology

The physiological metabolic activities of microorganisms would produce some polysaccharides and glycoproteins and other polymer organic matters. These polymer organic matters have a favorable flocculation efficiency, and some microorganisms have a similar chemical structure as flocculants. Microbial flocculation technology could achieve the sewage treatment by using microorganism flocculation (As shown in figure 2). At present, microbial flocculation technology is mainly used in agricultural wastewater treatment and wastewater decolorization treatment. The BOD content in agricultural wastewater is usually high, which is the largest difficulty in agricultural wastewater treatment. By applying traditional physical and chemical techniques to deal with agricultural wastewater is often unsatisfactory. In contrast, using microbial flocculation technology could effectively compensate for the shortcomings of the traditional physical and chemical treatment techniques and achieve extraordinary results. It has been demonstrated that after applying for agricultural wastewater treatment, TN and TOC have decreased by 45% and 75%,[6] respectively. Hence, compared with the traditional treatment techniques, microbial flocculation technology could achieve significant improvement in the treatment effect. Some industrial wastewater often contains a large number of soluble pigments. For a long time, decolorization against the industrial wastewater is a difficulty of wastewater treatment. By using microbial flocculation technology, soluble pigments in the industrial wastewater could be formed into flocculation precipitates so as to achieve decolorization of industrial wastewater. Practices have confirmed that after the treatment of microbial flocculant, the clarity of industrial wastewater has been significantly improved, and the safety of microbial flocculation technology is high.

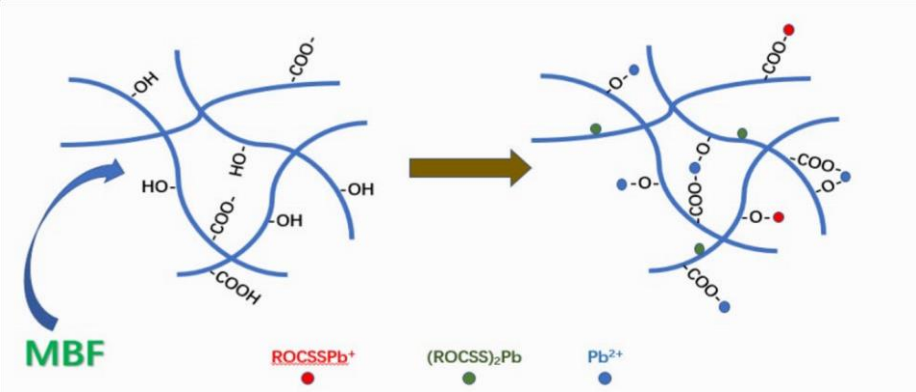

Figure 2. Microbial flocculation technology[7]

1.3 Microbial Immobilization Technology

Microbial immobilization technology refers to fixing the microorganisms with higher activity and free state in the sewage on a limited carrier to increase microbial concentration and activity in the local range of sewage. It uses microorganisms with high concentration and high activity to effectively adsorb organic pollutants in the local range of sewage so as to realize the purification of sewage treatment (As shown in figure 3). At present, among the practical applications of immobilized microbial technologies, the most common kinds are immobilized bacterial technology and immobilized enzyme technology. The commonly used immobilization methods include self-fixing, embedding, crosslinking, etc. The outstanding advantages of immobilized microbial technology lie in the simple processing equipment, the low processing cost, the high processing efficiency, the small amount of sludge, and the simple subsequent separation. Currently, it has been widely used in wastewater treatment. Immobilized microbial technology also has the advantages of designability and designation. In the application of immobilized microbial technology, an immobilized microbial treatment area could be designed according to the distribution of pollutants in the sewage. In addition, microorganisms can maintain high activity for a long time, and can be used repeatedly several times in immobilized microbial treatment technology. Hence, the application cost of this treatment technology could be effectively reduced and the treatment process is safe and environmentally friendly without secondary pollutants. Immobilized microbial technology has a broader application in wastewater treatment technology. Meanwhile, in the treatment of complex wastewater, we need to pay attention to the selection of microorganisms and carrier adaptability to ensure the effectiveness of wastewater treatment and the effective reuse of microorganisms.

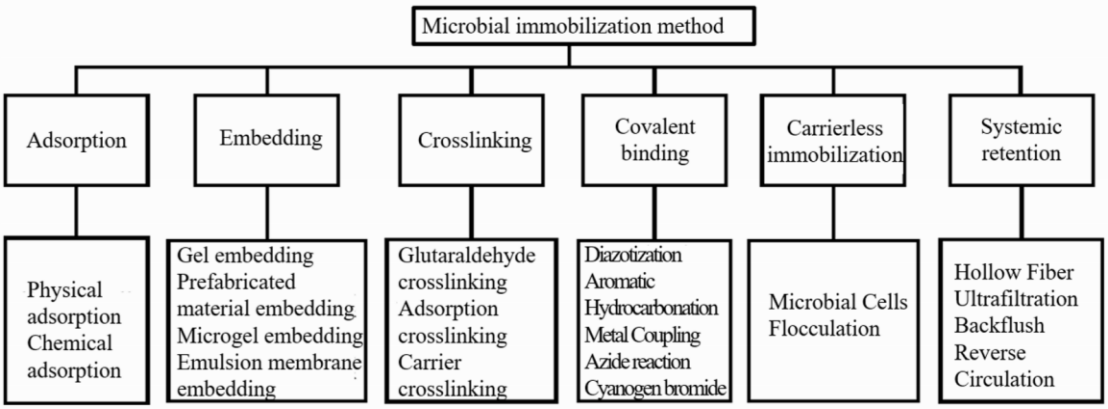

Figure 3. Microbial immobilization method [8]

1.4 Microbial transfer technology

Microbial transfer technology utilizes the redox effect, adsorption, and transfer effect of microorganisms on heavy metal ions and inorganic pollutants to realize the purification of heavy metal ions and inorganic pollutants in sewage. Some sewage contains a certain amount of heavy metal ions, such as iron, copper, cadmium, etc., and other inorganic pollutants, such as sulfur, phosphorus, etc. Currently, in the actual application of microbial transfer technology, sulfide microorganisms are used to achieve the transfer of sulfur, and Bacillus cereus is used to achieve the transfer of phosphorus. Besides, the microorganism adsorption is used to achieve the treatment of the cadmium element, and the microorganism redox action is used to redox iron, copper, and other metal ions to passivated state. (As shown in figure 4)

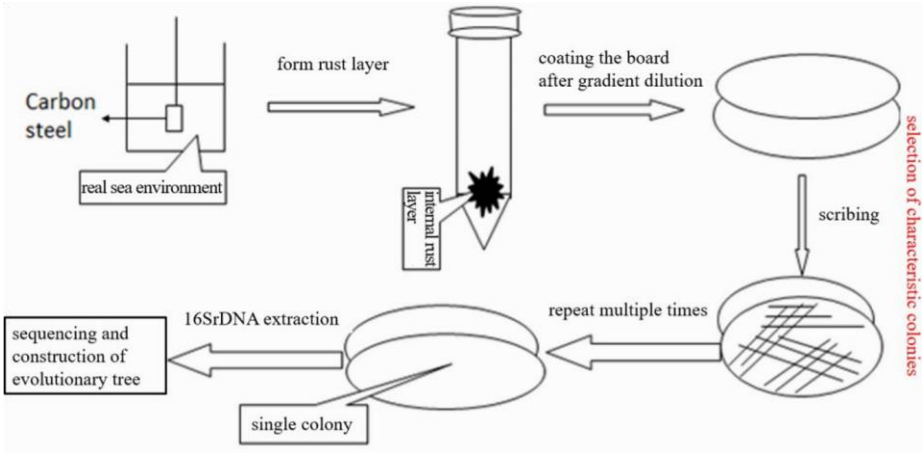

Figure 4. Microbial conversion technology [9]

1.5 Microbial Decomposition Technology

Microorganisms feature active physiological metabolism and fast growth and reproduction. Microorganisms would consume large amounts of nutrients in the physiological metabolism and growth and reproduction. Some sewage contains a large number of organic substances and could provide the nutrients needed for microbial physiological metabolism and growth and reproduction. Microbial decomposition technology is to achieve the treatment of organic-rich wastewater by taking use of the physiological characteristics of microorganisms. In the current practice, rod-shaped bacteria and globular bacteria are used in the treatment of sewage rich in ammonia and urea. Besides, Pseudomonas fluorescents are used to decompose protein substances in sewage into amino acids.

2. Conclusion

During the procedure of environmental treatment, microbial technology is a very effective technology and plays an important role in environmental wastewater treatment. Its application prospect is relatively broad. But at the same time, it is also faced with the shortcomings such as less application of populations and obvious influence of ambient temperature, etc. In practical application, we should take targeted microbial technology to deal with sewage according to the property, characteristics, and complexity of the sewage, so as to enhance the effectiveness of wastewater treatment as well as promote the quality of the water environment.

References

Moss B. Water pollution by agriculture [J]. Philosophical Transactions of the Royal Society B: Biological Sciences, 2008, 363(1491): 659-666.

Li Y, Wang M, Chen X, et al. Multi-pollutant assessment of river pollution from livestock production worldwide[J]. Water Research, 2022, 209: 117906.

Halder J N, Islam M N. Water pollution and its impact on the human health [J]. Journal of environment and human, 2015, 2(1): 36-46.

Hu Tingyong, Ding Shujiang. Explore rural water pollution and microbial technology governance [J]. Industrial Microbiology, 2023, 53(01):67-69.

Atiwesh G, Parrish C C, Banoub J, et al. Lignin degradation by microorganisms: A review [J]. Biotechnology Progress, 2022, 38(2): e3226.

Lian B, Chen Y, Zhao J, et al. Microbial flocculation by Bacillus mucilaginosus: applications and mechanisms [J]. Bioresource Technology, 2008, 99(11): 4825-4831.

Li H, Wu S, Du C, et al. Preparation, performances, and mechanisms of microbial flocculants for wastewater treatment [J]. International journal of environmental research and public health, 2020, 17(4): 1360.

Woodward J. Methods of immobilization of microbial cells [J]. Journal of microbiological Methods, 1988, 8(1-2): 91-102.

Shukla R ,Sarim M K ,Singh P D .Microbe-mediated management of arsenic contamination: current status and future prospects[J].Environmental Sustainability,2020,3(12):83-90.