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Present Situation of Resource Treatment Technology for Black and Odorous Water Bodies in Rural Areas

Qiushi Shi[1,2], Xi He[1,2], and Hao Wang[1,2]

[1] Key Laboratory of bioelectrochemical water pollution control technology in Tangshan City, North China University of Science and Technology, Tangshan, P.R. China

[2] College of Civil and Architectural Engineering, North China University of Science and Technology, Tangshan, P.R. China

Abstract

With the improvement of the rural economic level, the industrialization of urbanization has gradually accelerated. At the same time, it has also brought serious damage to the rural water ecological environment. More and more untreated pollutants are directly discharged into the water body, exceeding the self-purification capacity of the water body, resulting in black and odorous water bodies and causing serious water pollution. This study expounded on the characteristics of black and odorous water bodies in rural China, explored the causes of black and odorous water bodies, deeply analyzed the treatment effects of various treatment technologies on black and odorous water bodies in rural areas, and discussed the urgent needs of resource treatment of black and odorous water bodies in rural areas under the new situation of environmental protection. This study is of great significance for the study of rural black and odorous water bodies and the protection of rural water ecology and also provides a scientific basis for the prevention and control of rural water pollution. This study expounded on the characteristics of black and odorous water bodies in rural China, explored the causes of black and odorous water bodies, deeply analyzed the treatment effects of various treatment technologies on black and odorous water bodies in rural areas, and discussed the urgent needs of resource treatment of black and odorous water bodies in rural areas under the new situation of environmental protection. This study is of great significance for the study of rural black and odorous water bodies and the protection of rural water ecology and also provides a scientific basis for the prevention and control of rural water pollution.

Keywords

Rural Black and Odorous Water; Wastewater Treatment Technology; Cause; Recyclinvironmental Governance.

1. Characteristics and Causes of Black and Odorous Water in Rural Areas

1.1. Characteristics of Rural Black Odorous Water

The problems of low collection and treatment rate of domestic sewage in rural areas, direct discharge of small-scale livestock and poultry breeding sewage without treatment, and random disposal of domestic garbage all lead to the deterioration of water environment quality in rural areas, and even black odor [1]. Determined by transparency, dissolved oxygen, redox potential, ammonia nitrogen, and other indicators. The characteristics of black and odorous water in rural areas are as follows:①The color is dim, black, or dark green, emitting an unpleasant odor.②The water body is turbid and unclear, and suspended solids and biological flooding are visible. ③ Water contains high concentrations of organic matter, such as rotting plants, manure, pesticide residues, etc. This organic matter will consume oxygen in water, resulting in water

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hypoxia. ④The content of nutrients in the water is high, such as nitrogen, phosphorus, and other elements, which will promote the growth of algae in the water body and lead to further deterioration of water quality.⑤There are a large number of bacteria and viruses in water, which pose a potential threat to human and animal health. In addition, rural black and odorous water bodies are characterized by large quantity, small scale, regionalization, fragmentation, dispersion, poor self-purification ability, and large seasonal variation. The existence of black and odorous water in rural areas will not only affect the surrounding environment and ecosystem but also directly affect people's life and health. Therefore, it has become one of the important tasks in China to control rural black and odorous water bodies and ensure water quality safety.

1.2. Causes of Rural Black Odorous Water.

The main reason for the formation of black and odorous water in rural areas is that the concentration load of pollutants in the river exceeds the purification capacity of the river itself, which will lead to an increase in the concentration of pollutants in the water body. Microorganisms consume a large amount of dissolved oxygen in the water body during the degradation of pollutants, accelerating the anaerobic state of the water body, thus causing black and odor [2]. The blackening of water is due to the presence of metal sulfides in the overlying water, such as ferrous sulfide (FeS) and manganese sulfide (MnS), which are formed by the combination of Fe2 + and Mn2 + with S2 [3,4,5]. In water, reduced inorganic compounds combine with metal ions to produce black matter, which largely blackens the water and microbial sludge flocs[6]. Chromophoric dissolved organic matter (CDOM) can also lead to the blackening of water [7]. CDOM is a component of dissolved organic matter (DOM) that is leached from decaying large plants and consists of optically active substances such as amino acids, humic acids, and aromatic proteins[8].

Sulfur is one of the most important elements contributing to the formation of odor compounds. H2S is a strong odorous substance, which plays an important role in the formation of odor. VOSCs (MTL, DMS, DMDS, and DMTS) play a major role in odor formation [9]. Current studies have shown that sulfur-containing organic compounds and microbial degradation of sulfur-containing organic compounds may be the two main mechanisms for the production of VOSCs in water[10]. Sulfur-containing organic compounds are mainly released during the death and decay of cyanobacteria and submerged plants [11]. VFA is a malodorous compound that can be produced by organic compound fermentation or algae decomposition [12.13]. When sulfate is present, VFAs can be used as electron donors by sulfate-reducing microorganisms to support the production of malodorous sulfides. Nitrogen-containing compounds, including organic amines such as cadaverine and putrescine, also produce odors, mainly produced by proteolytic microorganisms[11].

2. The Urgency of Resource Treatment of Black and Odorous Water Bodies

Black and odorous water has become a serious environmental problem, which not only threatens people's life and health but also brings challenges to the sustainable use of water resources. Therefore, the resource treatment of black and odorous water is urgent. The resource treatment of black and odorous water refers to the effective recovery and utilization of beneficial components and energy in black and odorous water to achieve the purpose of reducing pollution and resource utilization. The beneficial components in black and odorous water mainly include organic matter, nitrogen, phosphorus, etc., which can be recovered and utilized by appropriate treatment methods. For example, the treatment of black and odorous water by biotechnology can convert organic matter into biomass energy, and extract nitrogen, phosphorus, and other elements as fertilizer. In addition, biomass energy can also be used to

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generate electricity to achieve energy recovery and utilization. The urgency of resource treatment of black and odorous water is that it involves two aspects: environmental protection and resource utilization. On the one hand, black and odorous water has caused great damage to the environment, and measures need to be taken to control it. On the other hand, the beneficial components and energy in black and odorous water bodies, if not effectively recycled and utilized, will waste a lot of resources. Therefore, the resource treatment of black and odorous water is an important work with both environmental protection significance and resource utilization value.

In summary, the resource treatment of black and odorous water bodies is urgent and important. It is necessary to take effective measures to strengthen technology research and development and experience summary, recycle and utilize the beneficial components and energy in black and odorous water bodies, and achieve sustainable utilization of resources and sustainable development of the environment.

3. Rural Black and Odorous Water Treatment Technology

In the treatment technology of rural black and odorous water, there are mainly physical remediation technology, chemical remediation technology, bioremediation technology, and ecological remediation technology.

Artificial aeration is usually used for physical repair. Since the microbubbles generated by aeration can provide a collection point for mass transfer between gas and liquid, aeration is widely used in wastewater treatment [14]. Most of the studies on the effect of aeration on the gas-liquid mass transfer process focus on the transition process from an undersaturated state to a saturated equilibrium state[15]. The availability of dissolved oxygen is usually the basic limitation of pollutant removal. The commonly used method to increase the dissolved oxygen content in water is to artificially introduce oxygen into the black and odorous water body for aeration, which can solve the problem of low dissolved oxygen in the black and odorous water body, thereby improving the vitality of aerobic microorganisms. Artificial aeration is a synergistic removal of pollutants in water through adsorption and degradation. However, this method has large power consumption and poor treatment of suspended substances in water.

Chemical methods are widely used and the treatment effect is better. To quickly improve the sensory effect of black and odorous water bodies and improve the transparency of water bodies, flocculation, and precipitants can be added to polluted water bodies. These chemicals can flocculate and precipitate with colloidal substances, solutes, and suspended substances in water, reduce the pollution of pollutants in black and odorous water bodies, and control pollutants at the bottom of the water. Electrocoagulation technology is a kind of water purification method based on electrochemistry. It uses current to dissolve the anode to produce cations (commonly Al3 +, Fe3 +, etc.) to realize the separation and removal of solids and dissolved pollutants in wastewater. The electrocoagulation reaction process is the result of the combined effects of adsorption neutralization, compression flocculation, oxidation, and air flotation, and its adsorption capacity is higher than that of general flocculants. The advantages of electrochemical processes include environmental compatibility, low cost, high efficiency, sludge minimization, and ease of automation, and have been used to remove other pollutants from water[16,17]. Electrocoagulation is an effective electrochemical method for the treatment of different types of polluted water. In recent years, it has received extensive attention due to its high efficiency in treating many stubborn pollutants [18]. Electrocoagulation can remove different pollutants through specific ways, and release a large amount of metal ions through electrolytic oxidation of the anode. These flocculant ions will eventually combine with the hydroxide produced by the cathode in water, aggregate into flocs, and then adsorb pollutants to form polymer precipitates, or float to the surface with the hydrogen produced by the cathode

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[19]. The chemical method has the advantages of simple operation, low investment cost, and operation cost, and good treatment effect. It is a good method in the treatment of black and odorous water. However, these chemicals are easy to cause secondary pollution of water and endanger benthic organisms in the water. If the selected reagents are improper, the degradation rate of chemical reagents is slow, which will affect the recycling of water. Therefore, the selection of chemical agents should fully consider the impact of agents on the water's ecological environment and aquatic organisms.

Microbial remediation technology can replace traditional physical and chemical methods in many cases. This technology mainly uses modeled microorganisms to achieve the purpose of purifying black and odorous water bodies through the absorption of pollutants by microorganisms, such as the biofilm method and the addition of microbial agents. It is necessary to analyze the water pollution and water quality and add the corresponding nutrients required for the growth and development of microorganisms according to the actual situation of the river. The biofilm method is to attach microorganisms to the surface of the filler or carrier to grow, thus forming a layer of membrane-like biological sludge, that is, biofilm, which is put into the polluted water body. By contact with the sewage, the microorganisms in the membrane adsorb and degrade the pollutants, thereby improving the water quality. In the process of microbial remediation, immobilized microorganisms have a certain removal effect on black and odorous water. The domesticated composite microorganisms were used to monitor the on-site treatment effect and microbial community of the typical river restoration process. The pollutant content decreased and the dissolved oxygen concentration increased, which proved that the domesticated microorganisms could effectively repair black odor [20]. This technology is convenient to manage and has little impact on the original ecosystem of the water body. An appropriate amount of microbial agents are put into polluted water. At present, the commonly used microbial agents are effective microbial flora and various microbial agents, which can rapidly degrade pollutants in water and improve the self-purification ability of water.

Ecological restoration technology is a common treatment method. This method utilizes some characteristics of natural ecosystems and improves them by artificial means to achieve the purpose of water purification. Ecological restoration technology usually requires the establishment of an ecosystem, including wetlands, artificial infiltration tanks, artificial lakes, etc. These systems can use the characteristics of natural ecosystems such as plants and microorganisms to adsorb, decompose and remove pollutants such as organic matter, nitrogen, and phosphorus in water, to achieve the purpose of water purification. In the selection of rural black and odorous water treatment technology, various factors need to be taken into account, such as the degree of water pollution, the purpose of treatment, the cost of treatment, etc. Different processing technologies have different advantages and disadvantages and need to choose their processing methods.

In summary, rural black and odorous water treatment technology is a complex and important issue. Through various methods such as physical remediation, chemical remediation, microbial remediation, and ecological remediation, it can effectively purify rural black and odorous water bodies, and protect the environment and people's health.

4. Conclusion

This study comprehensively reviewed the characteristics and causes of black and odorous water bodies in rural areas, discussed the compounds that cause black and odorous phenomena, and analyzed the production mechanism of black and odorous water bodies. The treatment technology of black and odorous water body was studied, and the rural black and odorous water body was treated by chemical treatment technology, physical treatment technology, biological treatment technology, and ecological treatment technology. It is also necessary to

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further study the mechanism of blackening and odor formation, and the treatment application conditions and mechanisms need to be further clarified. A good water ecosystem can not only play a role in soil and water conservation and climate improvement, but also indirectly protect people's health, maintain ecological balance, and achieve sustainable economic and ecological development. This study provides a reference for further clarifying the treatment methods of black and odorous water bodies and the ecological restoration of the water environment.

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