ISSN 2616-5872 Vol.5, Issue 10: 82-85, DOI: 10.25236/AJEE.2023.051011

The Application of Microbial Degradation Technology in the Treatment of Black and Odorous Water in Rural Areas

Chunyi Duan

Guangxi Polytechnic of Construction, 33 Luowen Road, Nanning, 530000, China

Abstract: *With the implementation of the national rural revitalization strategy, higher requirements have been put forward for the governance of rural water environment. Efficient microbial technology utilizes the characteristics of easy reproduction and strong degradation of microorganisms to isolate, domesticate, purify, and expand cultivation of microbial colonies. On this basis, Chemical oxygen demand (COD), P, N, etc. in the water are used as nutrients, and suitable colonies are selected to breed rapidly in poor water environment, so as to rapidly degrade organic pollutants in the water and improve the quality of the water environment. By screening native microorganisms in water and selecting microbial strains from the dominant colonies as microbial colonies, carrier matrices are used for microbial degradation through live water circulation and adsorption immobilization processes. Compared with the separate addition of solidified carrier matrix group and the addition of free microbial group, the degradation rate of various pollutants has been greatly improved, which can be better applied to rural black and smelly Water purification purification projects.*

Keywords: *Active water circulation; Microbial degradation; Rural areas; Black and odorous water treatment*

1. Introduction

At present, there are two main types of microbial environmental treatment technologies [1-2]: directly injecting free microbial strains into water; Immobilized microorganisms that are immobilized on the carrier substrate and injected into water. Immobilized microorganisms have been widely studied and applied in environmental pollution control due to their simple process, high pollution treatment efficiency, and low investment and operating costs. In terms of microbial degradation methods, commonly used methods include adsorption, embedding, and cross-linking. Each method has its own characteristics and is applied in different situations. In terms of the selection of microbial immobilization carriers, in addition to traditional carriers, special functional carriers have also been developed, such as biodegradable polymer carriers, magnetic carriers, and carbon source carriers, to achieve complementary advantages in the performance of various carrier materials. On the basis of relevant research, this article takes a polluted river channel in a certain township in Guangxi as the experimental object. By screening native microorganisms in the water and combining them with carrier matrix for microbial immobilization, the factors affecting the water purification effect of immobilized microorganisms are analyzed, in order to obtain a group of immobilized microorganisms and biological parameters with high water purification capacity.

2. Materials and Methods

2.1 Materials and reagents

The test water sample was selected from a river channel in a certain township in Guangxi, where the water body turned black and had obvious odor. The initial measurement indicators of black and odorous water are shown in Table 1. Take the overlying water under the natural flow state, store the water sample at 4 ℃, and place it in the liquid enrichment medium for Microbiological culture, so that the river bacterial colonies can reproduce and grow. After Microbiological culture and screening of water quality, 14 strains of microorganisms were isolated, and the optimal bacteria were selected as the primary microorganisms according to the comparison of pollutant degradation experiments. The immobilized matrix uses green zeolite with a mesh size of less than 60. The other reagents include HCl

ISSN 2616-5872 Vol.5, Issue 10: 82-85, DOI: 10.25236/AJEE.2023.051011

solution with a concentration of 1mol/L, Na-OH solution with a concentration of 20g/L, 10% physiological saline, sterile culture medium, and distilled water. The initial measurement indicators of village black odor water are: DO=0.08mg/L, NH_3-N=106mg/L, TP=25mg/L, COD=389mg/L.

2.2 Instruments and Equipment

The experimental equipment includes: electronic precision level; Ultra clean workbench; Constant temperature oscillation incubator; High pressure steam sterilizer; High speed centrifuge; UV visible spectrophotometer; PH meter; Mass spectrometer[3-4].

2.3 Experimental Methods

Firstly, rinsing with tap water to remove the dust attached to the substrate. Soak in 1mol/L HCl solution for 24 hours, then rinse 3 times with distilled water. Soak in 20g/L NaOH solution for 24 hours, repeat rinsing with distilled water, and finally immerse in 10% physiological saline for 24 hours. Remove and dry for later use. Weigh 30g of pre-treated substrate and prepared microbial liquid culture medium and place them in a steam sterilization pot for 30 minutes of moist heat sterilization. Take them out and soak them for 24 hours for use, as shown in Table 1.

Table 1: Setting of Experimental Comparison Groups

Experimental Comparison Group	Scheme Experimental			Enhanced Degradation Products
	Addition amount/%	Temperature/℃	Cultivation time/h	
Experimental groups	0~10	20~35	0~48	Add microorganisms
Control group A				Free bacteria
Control group B				Carrier matrix (green zeolite)

3. Analysis of test results

3.1 Effects of Different Additive Levels

The degradation effect of black and odorous water under different dosage was compared to Group A, and the optimal degradation effect was obtained when the dosage was 6.3%, with an optimal degradation efficiency of 50.3%. Due to the large amount of microbial addition, the COD content in black and odorous water increases, and it is not fully degraded by the 24-hour equilibrium, resulting in a significant difference in microbial addition and degradation efficiency. For the experimental group, when the addition amount is 10%, the degradation rates of COD in black sewage are 68.3% and 59.4%, respectively. At this time, the addition amount has the best degradation effect on black sewage.

The treatment effect of three groups on the TP index of black sewage is: when the addition amount is 10%, the TP index degradation rates of control group A, control group B, and experimental group on black sewage are 45.1%, 36.5%, and 64.5%, respectively. It can be seen from the comparison that the experimental group has a much higher treatment effect on black sewage than the other two groups. Considering that the control group A has a higher microbial biomass input and a higher utilization rate of TP in water, the removal efficiency of black sewage at a large dosage is significantly higher than that at a small dosage.

The analysis of the treatment effect of NH_3-N on black wastewater under three methods is that when the addition amount is 10%, the NH_3-N degradation rates of control group A, control group B, and experimental group on black wastewater are 46.8%, 58.6%, and 79.9%, respectively. The experimental group is significantly better than the other two groups, but the NH3-N treatment effect is better when the dosage is 5% and 10%. Therefore, from an economic perspective, choosing a 5% dosage is more suitable for large-scale application.

3.2 Effects of different temperature fields

The set biological addition amount is 5%, and the degradation effect of immobilized microorganisms at different reaction temperatures is measured on a constant temperature shaking culture medium. The higher the temperature, the better the removal effect of COD from black wastewater. The COD index degradation rate of the experimental group at 30 ℃ was 59.2%, which improved the treatment effect by nearly 6% compared to low temperature treatment conditions, and the removal effect was the best. The removal rates of control group A and control group B increased by 12.2% and 8.0% respectively compared to the same temperature, indicating that immobilized microorganisms have the best ability to degrade pollutants. The experimental group showed significantly higher treatment effects on TP and NH3-N indicators of black sewage at different temperatures compared to the other two groups. The degradation rates of TP indicators in black sewage in experimental group, control group A, and control group B were 80.3%, 53.6%, and 25.2%, respectively. The experimental group had the best treatment effect, while control group B had the worst treatment effect, indicating that the treatment effect of pollutants was limited under a single substance, but attaching microorganisms to the substrate significantly improved the treatment effect of microorganisms on black sewage. The treatment effect of each group on the NH3-N index of black sewage is similar to that of TP. As the temperature increases, the treatment effect becomes better. Among them, the experimental group has the best treatment effect on NH3-N, with a degradation rate of 71.6%.

The above analysis indicates that increasing temperature can promote the degradation of pollutants, while in reality, the outdoor water temperature in most areas is often lower than 30 ℃. Therefore, it is recommended to choose a water temperature of 20-25 ℃ for testing[5-6].

3.3 Effects of Different Degradation Times

The biological addition amount of the set substance is 5%, and the COD concentration of black and odorous water under different reaction times is determined by constant temperature shaking culture medium. The experimental group shows a gradual upward trend in COD within the first 2 hours, followed by a significant decrease, until reaching an equilibrium state after 24 hours. The maximum degradation rate of the entire process reaches 56.2%. In control group A, the COD concentration gradually decreased over time, reaching its maximum at 36 hours of reaction time, with a maximum degradation rate of 42.8%. The COD concentration of control group B changed significantly from 0 to 24 hours, and after 24 hours, the solution concentration slightly increased and reached equilibrium, with a maximum degradation rate of 49.2%. Considering that the increase in COD is partly due to the growth of microorganisms, followed by a significant degradation of pollutants in black water under the joint action of the substrate and microorganisms.

The trend of TP concentration in sewage with degradation time under different groups is as follows: in the first 2 hours, TP concentration in different groups rapidly decreases, followed by a gradual decrease, and the concentration tends to balance between 12 and 24 hours. The TP degradation efficiency of control group A and control group B remained around 40%, which was relatively close. The highest degradation rate of the experimental group reached 68.7%, significantly higher than the degradation efficiency of the first two groups.

The trend of NH3-N concentration over time in different groups: In control group A, the NH3-N concentration showed a convex trend, which first decreased, then increased, then decreased, and finally reached a basic equilibrium state. At the maximum NH3-N concentration of 7 hours, the NH3-N degradation rate reaches 42.1%. The degradation of control group B and CD1 group was basically the same, with a rapid decrease in pollutant concentration within the first 5 hours, followed by a gradual trend, reaching equilibrium at 3 hours. The highest degradation rate of control group B was 58.3%, while the highest degradation rate of experimental group was 77.6%.

The experimental results indicate that the degradation effect of pollutants is affected to a certain extent with the change of reaction time. After reaching the highest degradation efficiency of solidified microorganisms for a period of time, a balance state is maintained. Therefore, it is recommended to execute the degradation reaction time in a cycle of 24 hours.

3.4 Effect of immobilized microorganisms on black and odorous Water purification purification

The set addition amount is 5%, and the reaction temperature is 25 ℃. After 24 hours of degradation reaction, it can be seen that the degradation efficiency of COD, TP, and NH3-N in black water by the fixed microbial experimental group is 58.5%, 80.0%, and 61.1%, respectively; The degradation efficiency of COD, TP, and NH3-N in black water in control group B with the addition of solidified carrier matrix alone was 41.7%, 14.0%, and 63.1%, respectively; The degradation efficiency of COD, TP, and NH3-N in black water in group A, which added free microorganisms, was 31.7%, 36.9.0%, and 17.9%, respectively. There was also a certain decrease in various pollutants in the blank control group, indicating that the water itself still has a certain degree of self-cleaning ability. However, the COD content in control group A with only the addition of free microorganisms is relatively high, mainly due to the continuous reproduction of microorganisms as organic matter in black water, resulting in an increase in COD content in the water body. Moreover, the ability of microorganisms to

ISSN 2616-5872 Vol.5, Issue 10: 82-85, DOI: 10.25236/AJEE.2023.051011

degrade TP is higher than that of single substrate control group B. Comparing different groups, it can be seen that the experimental group has excellent removal effects on various pollutants, indicating that microorganisms during the solidification process can attach well to the substrate[7-8].

4. Conclusion

Aiming at the problem of black and odorous water in rural areas, the activated circulation Bio remediation method was used to treat black and odorous water pollution. By screening native microorganisms in water, we selected microbial strains as microbial colonies, fixing carrier matrices, and performing microbial degradation through adsorption and immobilization processes.

The degradation efficiency of COD, TP, and NH3-N in black water by the fixed microbial experimental group was higher than that of the group with separate addition of solidified carrier matrix and the group with addition of free microorganisms. This indicates that microorganisms can adhere well to the substrate during the activation cycle, improving the removal efficiency of various pollutants by microorganisms.

Comparing the effects of different factors such as the addition amount of immobilized microorganisms, degradation temperature, and degradation time on the degradation efficiency of immobilized microorganisms, it was determined that the most suitable degradation environment was the growth environment with the highest microbial degradation rate, where the addition amount was 5%, the degradation temperature was 25 ℃, and the degradation cycle was 24 hours.

Acknowledgements

The 2020 Guangxi University Young and Middle School Teachers' Basic Research Ability Improvement Project. Project name: Analysis of the Formation Mechanism and Treatment Measures of Rural Black and Odorous Water Bodies. Project number: 2020KY35023.

References

[1] Zhou Pengcheng. The application of live water circulation technology in the treatment of black and odorous water [J]. Shanxi Chemical Industry, 2023 (04)
[2] Zhao Yue; Yao Ruihua; Xu Min; Song Lingling. Practice and Discussion on the Treatment of Black and Odorous Water Bodies in Chinese Cities. Environmental Protection, 2015
[3] Guo C, Wei Y, Liu S .Application of computational fluid dynamics in the research on odorous-black water and physical treatment technology[J]. 2021. DOI:10.1088/1742-6596/2083/3/032006.
[4] Juang D J .Application of microbial fuel cell in wastewater treatment system by using algae as the oxygen supplier in cathodic chamber[C]//IEEE International Conference on Power System Technology. IEEE, 2013.DOI:10.1109/PowerCon.2012.6401459.
[5] Campos C, Oron G, Salgot M,et al.Behaviour of the fecal pollution indicators in a soil irrigated with treated wastewater under onsurface and subsurface drip irrigation[J].Water Science & Technology, 2000, 42(1):75-79.DOI:10.1029/1999WR900289.
[6] Liu M, Graham N, Xu L,et al.Bubbleless aerated-biological activated carbon as a superior process for drinking water treatment in rural areas[J].Water research: A journal of the international water association, 2023.
[7] Xu G, Ji J, Zheng Z,et al.Performance and Energy Utilization Efficiency of an Expanded Granular Sludge Bed Reactor in the Treatment of Cassava Alcohol Wastewater[J]. 2023.
[8] Sheng Z, Cui-Yun Z, Ze H E,et al.Application of bioremediation in oil contaminated soil[J]. Journal of Groundwater Science and Engineering, 2017. DOI:CNKI:SUN:DXSG.0.2017-02-003.