Study on Moderate Treatment Technology of Vegetation Restoration and Reclaimed Water in Northwest Desert Area

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Abstract. The main purpose of this project is to propose the requirements for the quality of recycled water suitable for vegetation reconstruction and conservation and soil environmental protection in mining areas. It is mainly to study the wastewater (mine domestic sewage) generated from coal bases in arid desert areas in northwest China, and use the treated recycled water for vegetation in mining areas. Reuse water and ensure good results of vegetation restoration. According to the information and field visits, it was found that domestic sewage in the mining area is similar to urban sewage, and COD, ammonia nitrogen (NH4+-N), Total nitrogen (TN) and total phosphorus (TP) are mainly removed. Therefore, it is necessary to carry out moderate sewage treatment according to the climatic characteristics of arid desert areas in the northwest (ie, drought, low temperature at night, and large temperature difference between day and night). The SBR reactor was used to moderately treat domestic sewage in the experiment. The optimized HRT was 6h; the optimal filler addition ratio was 1/4; the device treatment effect was best when the carbon-nitrogen ratio was 7/1; the effect is the best. The effluent COD at the optimal operating conditions is 58 mg/L, ammonia nitrogen is 9.4 mg/L, total nitrogen is 14 mg/L, and total phosphorus is 2.8 mg/L, which can meet the water quality standards for reclaimed vegetation restoration.

Introduction

Among the 14 large coal bases planned in China, the Ningdong Yangchang Bay coal base is located in the arid region of the northwest. The mining of coal has caused the ecosystem structure in the region to change, the ecological function to be severely degraded, and the stability of the original ecosystem to weaken. The region's already fragile ecosystems have caused great damage. The drought and water shortage in the northwest arid desert area combined with coal development have severely damaged the limited surface water and groundwater resources in the region. The domestic sewage in the mining area is the renewable water resources available in the mining area. The proper treatment of domestic sewage is of great significance to the ecological restoration of the mining area and to the ecological security of the arid desert area in the northwest[1].

Experimental Design

In this experimental domestic sewage treatment, a sequential batch reactor was used to form a composite suspended activated sludge and biofilm system with strong pollutant removal ability in the reactor. The tank of the SBR reactor is a cylinder, made of plexiglass, with a height of 50 cm and an inner diameter of 13 cm. An overflow is set at 2 cm from the top of the reactor. The effective volume of the reactor is about 5.6 L. The drain port on the right side of the reactor Set sampling port. The inlet pump adopts Lange BT300-2J peristaltic pump; the aeration sand head is used for aeration, and the aeration pump is selected from blue wave EP-9000 pump for aeration; JJ-1A digital display electric mixer is used for stirring; Set solenoid valve to automatically control water outlet. The water bath system can be used to control the temperature of the SBR reactor.
Results and Discussion

Determination of Domestic Sewage Water Quality in the Northwest Desert Area

After consulting relevant water quality standards for reclaimed water, combined with relevant literature data on reclaimed water used for vegetation restoration, and local test reports, the recommendation table for domestic sewage water quality in the Northwest Desert Area was finally obtained, see Table 1.

Table 1. Recommended table for domestic sewage water quality in the desert area of Northwest China.

| Test items (mg/L) | Rawwater concentration | Highest value of raw water | Effluent concentration |
|------------------|------------------------|---------------------------|-----------------------|
| NH₄+-N           | 42.91                  | 79.4                      | 20                    |
| COD              | 440.82                 | 729                       | 65                    |
| TP               | 8.48                   | 17                        | 4                     |
| TN               | 44.31                  | 60.4                      | 25                    |

Optimization of Hydraulic Residence Time in SBR Reactor

This experiment examined the optimal hydraulic retention time of the SBR reactor. The results showed that the effluent COD concentration of the hydraulic retention time of 4 h and 5 h did not meet the effluent standard. The effluent concentrations of nitrogen and phosphorus also met the standards, and the effluent concentrations of COD, ammonia nitrogen, and total phosphorus with a hydraulic retention time of 7 h also met the effluent requirements and the effluent water quality was better. Nitrogen and phosphorus concentration as nutrients for vegetation during irrigation. Therefore, the optimal reaction time in this study is 6 h. SBR device effluent water quality: COD 58 mg/L, ammonia nitrogen 9.4 mg/L, total nitrogen 14 mg/L, total phosphorus 2.8 mg/L, which not only ensures the effective removal of organic matter, but also guarantees a certain amount of nitrogen and phosphorus concentration as vegetation during irrigation Nutrients[2].

Finally, the overall operating conditions of the SBR unit are: water inlet 0.25h, anaerobic 1.5h, anoxic 1.5h, aerobic 3h, sedimentation 0.5h, drainage 0.25h, and sludge drainage 10d.

Optimization of Optimal Feeding Ratio of SBR Reactor

In this experiment, three different proportions of fillers 1/2, 1/3, and 1/4 were selected. The effect of the device equipped with 1/2 filler addition ratio is not good because the filler is too much
accumulated, which affects the full contact between the biofilm and the sewage. The effect of a device equipped with a 1/3 filler loading ratio is close to the effect of a device equipped with a 1/4 device, considering economic principles. The final optimized filler addition ratio is 1/4, and the effluent quality of the SBR system is COD 60 mg/L, ammonia nitrogen 10 mg/L, total nitrogen 15 mg/L, and total phosphorus 3.7 mg/L. At the same time, the processing effect of the system is guaranteed. Moderately handle the economics of principles and systems.

![Graph 1](image1.png)

**Figure 2.** Water Concentration of Major Pollutants at 1/4 Filler Proportion.

**Investigation on the Effect of Carbon-Nitrogen Ratio on the Water Output of SBR Reactor**

![Graph 2](image2.png)

The experimental results show that the removal rate of COD is high when the ratio of carbon to nitrogen in the feed water is from 3: 1-11: 1, mainly because the biofilm on the surface of the filler has a strong ability to remove organic matter, which indicates that the system has a strong Load resistance. When the carbon-nitrogen ratio is 7: 1, the reactor has the best treatment effect. The COD removal rate reached 90.77%, ammonia nitrogen was 91.97%, total nitrogen was 68%, and total phosphorus was 81.87%.

![Graph 3](image3.png)

**Figure 3.** Effluent concentration of main pollutants under different carbon-nitrogen ratios.

**Effect of Temperature on the Treatment Effect of SBR Reactor**

The treatment of domestic sewage by microorganisms is the removal of organic matter by the use of enzymatic biochemical reactions in the microorganisms. Therefore, the type and quantity of enzymes in the microorganisms have a greater impact on the treatment effect. Because the
biological protein activity is greatly affected by the organism, the temperature is the biofilm method. An important influencing factor for treating aquaculture wastewater, water temperature has a great effect on the growth and reproduction of microorganisms. Under normal circumstances, various biochemical reactions in microbial cells are always coordinated with each other. Changing the temperature will definitely affect a variety of biochemical reactions in the microbial body. At the appropriate temperature, the enzymatic biochemical reaction proceeds normally, but at the inappropriate temperature, the morphology and metabolic activity of the microorganism are affected, and it may even lead to the death of the microorganism. The experimental results are shown in Table 2.

Table 2. Effect of temperature on the treatment effect of SBR reactor.

| Testitems(°C) | COD  | NH4+-N | TN   | TP  |
|--------------|------|--------|------|-----|
| 5°C          | 270  | 27     | 30   | 5.8 |
| 10°C         | 199  | 21     | 25   | 4.33|
| 15°C         | 110  | 15     | 17   | 3.45|
| 25°C         | 57   | 5.1    | 14   | 2.58|

It can be seen from the results in Table 2 that the effect of temperature on nitrate bacteria is greater than that of nitrite bacteria at 5°C, resulting in the accumulation of nitrite in the effluent, and the denitrification activity is also inhibited, resulting in poor effluent effect. The treatment effect of the reactor was greatly improved at 10°C. As the temperature rises, microbial activity increases, and growth and metabolism flourish. For biofilm systems, the microorganisms on the surface of the filler are mainly temperature-sensitive microorganisms. Increasing the temperature can increase the DO of metabolites, thereby increasing the metabolic activity of the microorganisms. Each microorganism has its minimum temperature, optimum temperature, maximum temperature and lethal temperature. Too low or too high temperature will bring irreversible damage to the microorganism body, and the growth rate of microorganisms will be inhibited, and it may even cause The damage and deformation of proteins and enzymes cause microorganisms to lose their metabolic functions, stop their growth, and eventually lead to death. The reactor treatment effect is best at 25°C.[3]

Conclusion

When the optimal hydraulic retention time of the SBR reactor is 6h, it can reach the water output standard and meet the economic principle.

When the filling ratio is 1/4, the SBR reactor not only meets the effluent standard, but also meets the economic principle.

When the carbon/nitrogen ratio of the feed water is 7/1, the SBR reactor treatment effect is the best.

The effluent effect of SBR reactor is best at 25 ℃.

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