The Periliminary Study of Using Microbial Remediation Agent to Control Eutrophication

Ma Wenlin*[1,2], Liu Jianwei[1,2], Li Rongqi[3], Tian Shihong[4], Hou Qin[1,2]

1Key Laboratory of Urban Stormwater System and Water Environment (Beijing University of Civil Engineering and Architecture), Ministry of Education, Beijing City, China, 100044

2Department of Environmental Engineering, Beijing University of Civil Engineering and Architecture, Beijing City, China, 100044

3 Beijing Created Biotechnology Co., Ltd., Beijing City, China, 100095

4 Maritime Safety Administration of San Ya City, Hainan Province, China, 572000

mawenlin1130@126.com

Abstract: Reclaimed water has been used as supply water of urban rivers and lakes instead of clean water, which relieves the water-needing pressure of the landscape water. However, the residual nitrogen, phosphorus and other nutrients in reclaimed water maybe aggravate eutrophication degree of landscape water. The experiment of using microbial mediation agent to restrain eutrophication was induced. It was observed that the algae change its growing pattern from on the water surface to the whole water body by spraying microbial remediation agent to water body. The landscape of water body got an improvement. The experimental results were analyzed and discussed in this the paper.

Key Words: microbial remediation agent; landscape water body; eutrophication

1 Introduction

It is an available means to use reclaimed water as ecological supply water of the river and lake in the city instead of clean water. This can relieve the present situation of water shortage to landscape water body. In recent years, there are more and more urban rivers and lakes in our country, eapecially in the northern area, such as Beijing's south moat, the Kunyu river, the Gaobeidian lake, the Longtan Lake, Hai river and Weijin river in Tianjin and so on, began to use the reclaimed water as supply water source[1]. However, because of considerable nitrogen, phosphorus and other nourishment in the reclaimed water and the poor fluidity of the water bodies, they enable these water bodies easy to develop into the eutrophication [2-4].

Microbial remediation agent has been widely used in agriculture, animal husbandry and aquaculture to improve water quality, and also has been used in controlling eutrophication of the rivers and lakes[5]. In this experiment, a kind of microbial remediation agent developed by Beijing Puren eco-company was used to rehabilitate water quality of a Beijing city park with reclaimed water as supply water. The experimental results can provide methods and technical data for maintaining landscape water's quality.

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2 Experimental Principle

When water body is in serious eutrophication, carbon source in water for algae growing is shortage comparing for nitrogen or /and phosphorus. Some algae, such as cyanobacteria, which can float on the water surface and absorb carbon dioxide from the air, become the dominant species and grow extansively[6]. The thick cyanobacteria floating layer is not only affect the landscape and environment, but also release algal toxins to water[7].

Microbial remediation agent used in this experiment is a kind of liquid substance, including complex microorganisms, algae nutrition regulator and coated materials. The microorganisms can rapidly decompose organic matters in water and change organic carbon into carbon dioxide, which continuously supplies the carbon source to the algae, and eliminates the trend of algae growing in the surface of eutrophic water. Algaes are distributed evenly in the different depth of the water layer, which can significantly improve the landscape, maintain the algae's diversity in water body, but also mitigate against the consequences of eutrophication.

3 Experimental Methods

3.1The situation of the testing water body

The park built in 1958 is located at Chaoyang District in Beijing. It has been a leisure, entertaining and exercising yards for the neighborhood residents since then. Its total area is 40 hectares, and water surface area 16 hectares.

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The Dongsi ring circuit Road divided the water surface into two connected parts-the East Lake and the West Lake. The West Lake area is small, and there is a fishing garden. The East Lake area is the main landscape tour area of the park, and the tourists can boat in it.

The water source of the park has used reclaimed water from a reclaimed water plant in Beijing since 2005. The park intently supplies water 4 times a year, 50,000 m^3 each time. From June to september every year, the water body always stagely erupt water bloom in large area, which needs cost a large number of money to manage it. Up to now, it has been unable to eradicate the water bloom.

3.2 Experiment plan

3.2.1 The use of microbial remediation agent

An experiment was induced to test the performance of microbial remediation agent on improving the water quality of eutrophic water body in 2008. It led to reconstruct a good aquatic ecosystem to spray microbial remediation agent to the water surface, for which its material circulating path became smooth, and water quality improved. During the trial, the dose of microbial remediation agent is showed in Table 1.

Table 1 the dose of microbial remediation agent (t)

time	dose	time	dose
April 24	3	Jule 27	0.5
May 26	5	July 04	4.2
Jule 18	3.5	July 16	3.2

3.2.2The sampling method

It is determined to set up 4 sampling points in this water body, as shown in Figure 1. During April to October in 2008, we gather water samples in 4 sampling points separately at 9:00-11:00 in the morning at each middle ten days every month. Water temperature, DO and pH were measured on-site with portable metering equipment at 0.5m depth of the sample points. At the same time, we gathered 1L water sample in each sampling point and took them back to the laboratory. They were preserved at 4℃ in the refrigerator to determine the water body chemistry indexes.

3.2.3 Water quality monitoring indexes and methods

There were nine items of water quality indexes , such as pH, temperature, DO, total phosphorus, total nitrogen, COD_{Cr}, ammonia nitrogen, soluble phosphorus, chlorophyll-a and so on. Each index was determined following "Water and Waste water Monitor Analysis method" (the fourth edition) issued by the national environmental protection department.

4 Test Results and Analysis

During the experimental period, water samples were collected at four sample points once per month. Water quality in every point was measured separately. The average values of the four-point were on behalf of the water quality of the whole lake.

4.1 physics indexes of the water body

From April to October in 2008, we carry on monitoring the water body's DO, pH and the water temperature. The result is shown in Figure 2. The data in Figure 2 show that DO and pH of water body have the basically consistent change rule. DO and pH are higher in spring and autumn than in summer, which is exactly opposite with the year water temperature change situation, and conforms to the general rule.

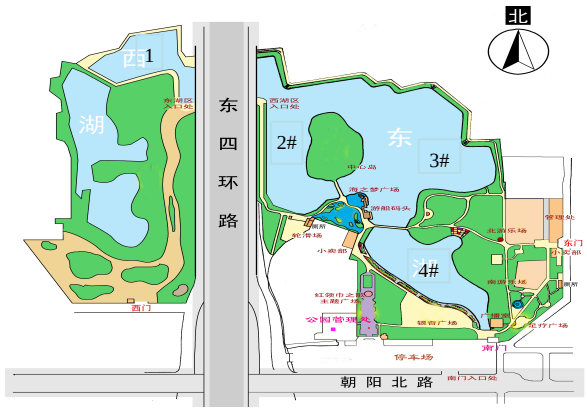

Figure 1. Sampling points
(1 # - East exit of West Lake District; 2 # -West bank of East Lake District; 3 # -The middle of the big lake in East Lake District; 4 # - The middle of the small lake in East Lake District)

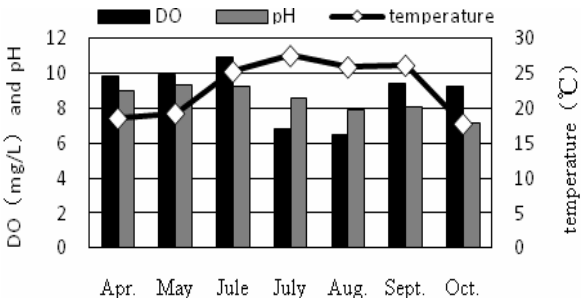

Figure 2. DO, pH and water temperature changes in water

4.2 Correlation between COD_{Cr} and DO

Figure 3 shows that the concentration of COD_{Cr} in the water remains below 50mg/L throughout the year, which

could meet the water quality demands of the landscape water. In general, because of the high water temperature in summer, microbial activity will increase, and part of organic matter deposited in the sediment is decomposed and released into the water, causing the rising COD_{Cr}. In this trial, we deliver microbial remediation agent into the water in the late April. There appears an inflection point of COD_{Cr} concentration in the late May. From July to August, organic matter in the water is significantly reduced. The remediation agent was stopped to use from the middle of July. Then, COD_{Cr} is significantly increased in September. All of these indicate that microbial remediation agent has a strong ability to decompose organic matter.

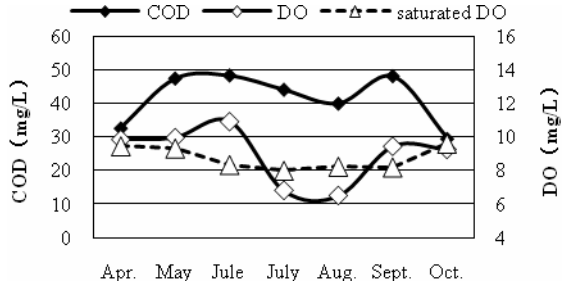

Figure 3. correlation between CODCr and DO in the water

Comparing the actual DO concentration in water with its saturated DO, it can be shown that when the water temperature is below 20 ℃ in April, May and October, the DO concentration in water is close to its saturated value; when water temperature remains at 25 ℃ -26 ℃ or so from June to September, there were two kinds of situations. The DO concentration in water is over saturated in June and September, but at a loss of oxygen status in July and August. COD_{Cr} has significant positive correlation with DO of the water in the park, which indicates that organic matter degradation is the leading reason of DO declining.

4.3 Correlation between DO and Chl-a

The correlation between chlorophyll-a and DO is shown in Figure 4. According to Figure 4, the data show that the concentration of chlorophyll-a in water is higher in September, and in other months it stays at 40mg/m^3 -80mg/m^3. Comparing the level of DO with the chlorophyll-a value, there is a poor correlation between them. After deep analysis, two reasons are concluded. First, there are many factors impacting DO concentration, such as algal photosynthesis, the change of water temperature, the algae respiration and organic matter degradation; Secondly, microbial remediation agent makes the algae no longer concentrate on the water surface, but distribute uniformly along the depth.

In this experiment, we gather water samples below 0.5m of the water with the sampling instrument to determine chlorophyll-a in water. From Figure 4 we can see that chlorophyll-a density maintains relatively low during May to August, but there was an obviously increasing in September. In fact, under the regulation of microbial remediation agent during May to August, the algae in the water is distributed uniformly, causing the density of chlorophyll-a on the water surface to drop. Perhaps, the total quantity of algae in the entire water body in July and August is not lower than that in September. This needs further experiment to confirm.

4.4 Correlation between Total phosphorus and Chl-a

The correlation between total phosphorus concentration and chlorophyll-a correlation is shown in Figure 5. According to Figure 5, the TP in water was less than 0.2mg/L in most cases from April to August, which could meet the water quality standards for landscape water. However, the TP in the water continues to decline from May to August, and chlorophyll-a was not at the same of change. But both of them rose in September.

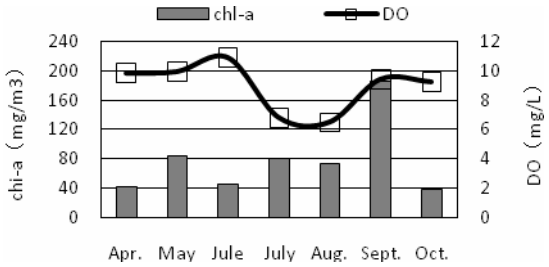

Figure 4 correlation between chlorophyll a and DO in the water

Many researchers approve that phosphorus is a restrictive factor of eutrophication[8], because the algae can only obtain the phosphorus from the water body, but many kinds of algae may utilize nitrogen in the air[6]. Microorganism remediation agent could promote organic matter decomposition and provide more CO_2 to meet the need of algae growth. Because phosphorus in water was absorbed by algae during their rapidly growth process, TP in water continuously declined from April to August. After the repair medicinal preparation was stopped to use in late July, the remediation effect maintains a month. Then, the phosphorus density in water presents a bounce in September. The reason is that, after stopping the use of remediation agent, there was smaller CO_2 in water supplied to the algae's growth, which causing algae's low growth rate. Therefore, there is fewer phosphorus to be used, and causes a phosphorus concentration rising. At the same time, the CO_2 in water is relatively deficient, and the algae gather onto the water surface to use the CO_2 in the atmosphere, which makes the algae concentrate to the water surface and induce the density of chlo-

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rophyll-a in 0.5m water depth increasing correspondingly. Certainly, this also needs further experimental to confirm.

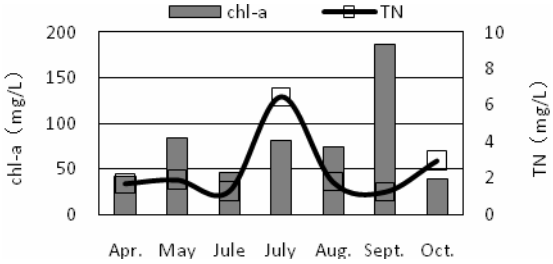

Figure 5 correlation between total phosphorus and chl-a

5 Evaluations and Suggestions

5.1 Evaluations of water quality restoration effect

According water quality monitoring results, the water body eutrophication degree and correlation between each water quality indexes were analyzed thoroughly.

(1) An experiment of using microbial remediation agent to restoration of eutrophic water body was done in a Beijing park with reclaimed water as its supply water source from April to October in 2008. The experimental results show that, in the most months around the year, the concentrations of COD and TP maintain below 50mg /L and 0.2mg/L seperately, which could meet the landscape requirements.

(2) During the period from May to August, under the continuously using microbial mediation agents, the concentrations of COD and TP in water declined constantly, but chlorophyll-a concentration remained stable, indicating that this remediation agent has the function of eliminating water pollution, improving the condition of the eutrophication.

5.2 Suggestions

Although the preliminary study indicates that the microbial remediation agent can regulate biochemistry reaction process in water body, and eliminate the eutrophication tendency of the water body in a short time, but we do not have a thorough research on the work mechanism of microbial remediation agent. In order to promote its using, there needs further discussion on its remediation mechanisms.

In addition, if we want a fundamental solution to the problem of water body eutrophication, a healthy aquatic eco-system must be built up to bring material cycle and energy flow in water into a smooth path. Microbial remediation agent can promote the development of primary productivity of water bodies. Then, the chain of producers and consumers continue to be constructed, which is an important measure to keep the controlling effects of water pollution stability.

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