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Bio-Safety Evaluation for Biocomposites Flocculation Purified Polluted Water of Shenzhen Offshore

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Abstract. The coastal water of Shenzhen western was seriously polluted. In this paper, the polluted water was treated by a series of composite flocculants. By selecting the best composite flocculants companied with bacterium for water treatments, the results have shown better effects. The turbidity of treated water decreased by 93.82%, the NH_3-N level decreased by 86.13%, the TN decreased by 83.41%, the TP decreased by 78.97%, the COD decreased by 81.27%, and the level of harmful marine vibrio decreased by 98.25%. The results showed that selected flocculants companied with bacterium treatment can greatly reduce the mortality of shrimps to 34% from 100%**.** Our results demonstrate that composite flocculants companied with bacterium can be used for the effective treatment of coastal wastewater, and it was safe to both the marine life and marine environment. This study established solid theoretical and practical foundations to control coastal pollution and restore the coastal ecology.

Keywords: Shenzhen coastal polluted water, biocomposites flocculation, companied with bacterium, treatment, bio-safety evaluation

1. Introduction

The heavy pollution of coastal water is a serious problem all over the world. So is Shenzhen western offshore water [1], [2]. There were many methods to be used to purified the pollution of water. Such as sustainable plant-based repair method has been introduced in Europe [3] and USA [4]. And the salt tolerance and restoration plants have been investigated by Linfeng of China [5]，the technology was applied in a bio-floating bed [6], [7]。But it costly and spent so long times. Recently, microbial communities were used to reduce discharge of coastal sewage [8]-[10]. Flocculation precipitation technology has been widely used as the main technology of sewage treatment [11]. But it seldom used in treatment of coastal pollution water. Materials and Methods

Recently, microbial communities have been used to reduce the discharge of coastal sewage [12]. There are some reports on microbial compounds used in marine aquaculture wastewater restoration [13], but few of microbial compounds used in polluted marine water restoration [14]. However, this method had many unstable factors because of the mobility and openness of the neritic zone and tidal changes [15]. Therefore, further efforts are needed to solve the problem of offshore pollution. Coastal water purification and silt clearance are greatly needed in order to restore the coastal ecology.

2. Manuscript

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2.1. Submitting

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3. Materials and Methods

3.1. Sample collection

The wastewater was sampled in Oct.-Nov. 2012 at Qian Hai Bay polluted water was sampled at Qian Hai Bay Feb-Mar, 2013 locating at E113 degree (113,78', 53.25"); N22 degree (22,48' 50"). (H: 3.9 m, precision: 4.1 m). And Da Chan Bay, locating at E115 degree (113, 35', 40.67"); N23 degree (23, 13' 12"). (H: 3.3 m, precision: 3.8 m).

3.2. Slection of flocculants

Shenzhen Dachan bay offshore wastewater was treated using different flocculants (Table 1), The reagent (A) chitosan acetic acid solution (CTS), (B) Polymerization aluminum chloride (PAC), (C) cation polyacrylamide (PAM^{+}) was added to 10 L wastewater respectively and mixed well at first. After 10 minutes, b(SA) was added to each mixture and mixed well. Wastewater that untreated was used as the negative control (Table 1).

Table 1: Different ratios and dosages of environment friendly composites used in processing aquaculture wastewater (10ppm respectively)

groups	1	2	3	4
bio-compositesr atios	A +b	B+ b	C+ b	Negative

3.3. Instrumental analysis

The DO was determined in situ by a portable multiparameter analyzer (HACH, HD30). Then the supernatant was detected after treatment. Other chemical parameters such as turbidity, Chemical Oxygen Demand (COD), and other nutrients such as ammonia nitrogen (NH3-N), total nitrogen (TN) and total phosphate(TP), were determined according to the standard analytical methods for the examination of marine water and waste water.

Harmful marine vibrio was cultured at 30℃ in TCBS (thiosulfate citrate bile salt sucrose agar)culture medium , then counted the number of single colony.

3.4. Select the best groups to companied with bacterium to decontaminate the coastal polluted water.

Select groups (Ab) that had the best decontamination effect companied with bacterium (nitrifying bacteria and Bacillus subtilis) , Shenzhen western coastal polluted water was treated by different composite flocculants companied with bacterium (Table 2), It had three groups (I, II, III-negative control groups).

Group II, the best composite flocculants Ab companied with bacterium (nitrifying bacteria and Bacillus subtilis)

Table 2: The groups of different composite flocculant companied with bacterium (nitrifying bacteria and Bacillus subtilis) used in polluted water treatment(10ppm respectively)

groups	I	II	III (Negative Control)
composite flocculant	Ab	Ab+Bacterium	Control

3.5. Bio-safety evaluation of best selected flocculants groups companied with bacterium to decontaminate the coastal polluted water.

Select groups that had the best decontamination effect companied with bacterium (nitrifying bacteria and Bacillus subtilis). In order to assess whether the composite flocculants is safe for aquatic life, and will notcause the second polluted toxic effects, 100 shrimps from a sample collected from coastal water were placed into each water sample respectively after treatment by composite flocculants. The shrimps were cultivated for 5 days. The shrimp mortality rate was recorded daily for five consecutive days. Then five days mortality was statistically analyzed. Four enzyme activities were detected according to the kits of

instruction book. The kits were purchased from Nanjing Jiancheng Bio-engineering Institute (China, Nanjing Jiancheng). The four enzymes detected were immune-related factors of muscle and lived from the shrimps, It included alkaline phosphatase (AKP) , esterase (CAT), malonaldehyde (MDA)and superoxide dismutase(SOD).

4. Results

4.1. Water quality is improved by treatment of flocculants

In the present investigation, Water quality of the biocomposites flocculation treatment showed by Fig. 1 and Fig. 2. The results showed the water quality of different indicator was improved observably.

That groups 1(Ab) was remarkable optimum, it improved the OD of polluted water up to 5.9~7.3 mg/L from 0.5 mg/L, and reduced the turbidity to 0.5~2.3 from 8.9, reduced NH3-N to 2.3~4.8 mg/L from 12.9 mg/L , reduced TN to 3.2~6.7 mg/L from 15.1 mg/L and reduced TP to 0.05~0.33 mg/L from 0.75 mg/L(Fig. 1). Reduced COD to 40.3~80.1 mg/L from 409 mg/L and marine darmful vibrio to 12~48 mg/L from 134 mg/L (Fig. 2).

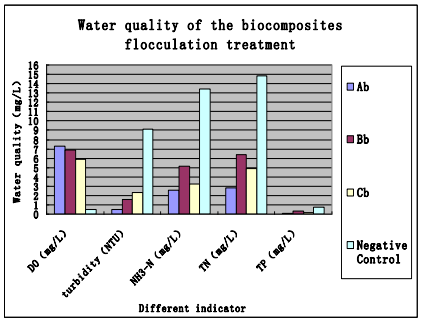

Fig. 1: Water quality after biocomposites flocculation treated (DO, turbidity, NH3-N, TN and TP)

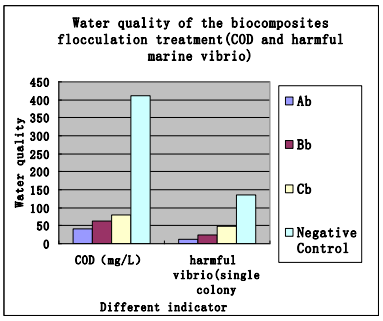

Fig. 2: Water quality after biocomposites flocculation treated (COD and harmful marine vibrio)

4.2. The removal rate (RR) of polluted matter treated by biocomposites flocculation

The removal rate (RR, compared with negative control) of turbidity was 66.9~80.1%, and The removal rate (RR) of ammonium nitrogen (H_4N^+-N) was 55.2~92.1%. The removal rate (RR) of TN was 56.8~81.1%. The removal rate (RR) of COD was 80.6~90.2%. The removal rate (RR) of TP was 55.8 ~ 92.6%. Removal Rate of harmful marine vibrio was 64.9 ~ 91.1%. Among those flocculants, group1 (Ab) showed the best results (Fig. 3).

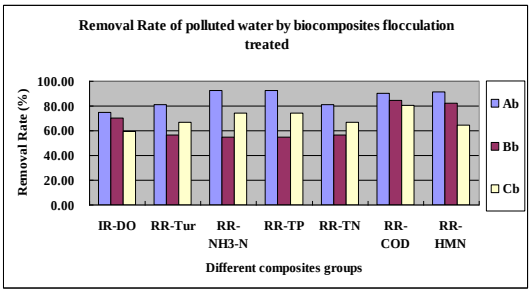

Fig. 3: Removal Rate of polluted water by biocomposites flocculation treated

4.3. Water quality is improved by treatment of best flocculants companied with bacterium

From selecting the best groups, group1 (Ab) companied with bacterium was used to decontaminate the coastal polluted water. The results showed that various flocculants yielded measurable improvements. DO increased to 8.3 mg/L and the turbidity reduced to 0.6NUT. TN, TP, NH_3-N, COD and harmful marine vibrio decreased significantly. Among those flocculants, Group II, the best composite flocculants Ab companied with bacterium (nitrifying bacteria and Bacillus subtilis) showed better results than group I (Fig. 4, Fig. 5).

The removal rate (RR, compared with negative control) of turbidity of treated water decreased by 93.82%, the NH_3-N level decreased by 86.13%, the TN decreased by 83.41%, the TP decreased by 78.97%,

the COD decreased by 81.27%, and the level of harmful marine vibrio decreased by 98.25%.(Fig. 6). The results showed that group II was better than group I.

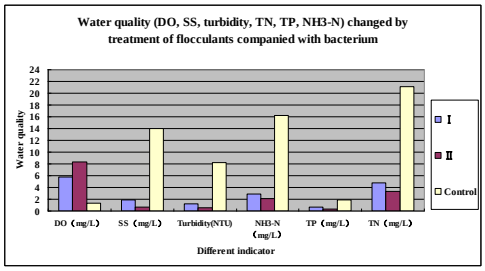

Fig. 4: Water quality (DO, SS, turbidity, TN, TP, NH3-N) changed by treatment of flocculants companied with bacterium

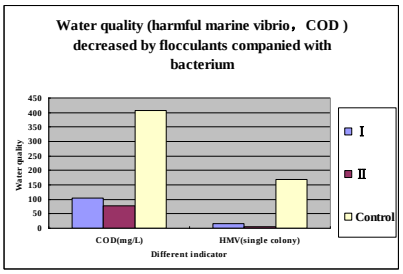

Fig. 5: Water quality (harmful marine vibrio，COD) decreased by biocomposites flocculants companied with bacterium

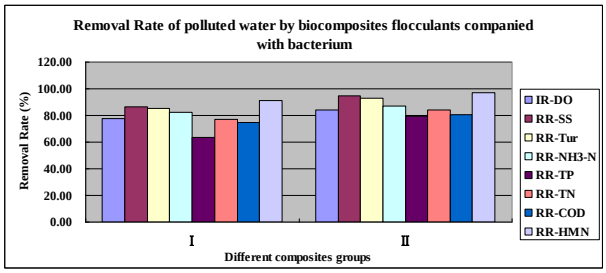

Fig. 6: Removal Rate of polluted water by biocomposites flocculants companied with bacterium

4.4. Bio-safety evaluation after flocculants companied with bacterium treatment

Five days mortality of shrimps that cultivated for 5 days was statistically analyzed. The shrimps were cultivated in samples for five days, nad their daily mortality rates were measured and the results were analyzed (Fig. 7). The results showed that selected flocculants companied with bacterium treatment can greatly reduce the mortality of shrimps to 34% from 100%, and it was not only lower than the control group, but also lower than the ***flocculants*** **treated groups.**

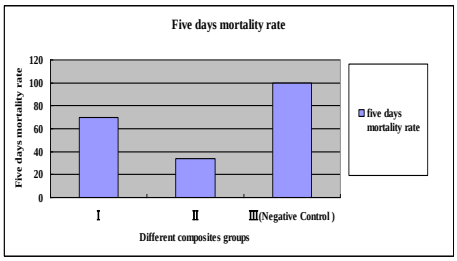

Fig. 7: Five daies mortality rate after the biocomposites flocculants companied with bacterium

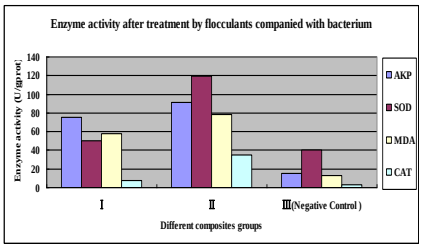

Fig. 8: Enzyme activity after treatment by flocculants companied with bacterium

In the meantime, all the shrimps exhibit stronger enzymes activity than the negative control and the *flocculants* treated groups (Fig. 8). All the values of the four kinds of enzymes (AKP, CAT, MDA and SOD) of the shrimps were higher than in the negative control and the *flocculants* treated groups. The results showed the methods can greatly increase the enzymes activity of shrimps treated by flocculants companied with bacterium, and it was not only higher than the control group, but also higher than the flocculants treated groups.

5. Acknowledgements

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