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PURIFICATION SYSTEM OF OCEAN SLUDGE BY ACTIVATING MICROORGANISMS

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ABSTRACT: Ocean sludge exerts a very big environmental load to local sea area. Here, attention was paid to micro-bubble technology for application to the purification of sludge. The important point in this technique is to activate the bacteria existing in the area by micro-bubbles. We had developed a method for decomposing the sludge by using of microorganisms in an aerobic state by micro-bubble. In this study, our objects are to develop a new powerful purification system for sedimentary sludge using a micro-bubble device and by activating microorganism. As the results of our experiments, we succeeded in reducing the time needed to purify the sludge.

Keywords: Micro-bubble, Microorganism Activator, Purification of Sludge, System on Circulating Type

1. INTRODUCTION

It is very important to reduce sedimentary sludge in the ocean. Plans to reduce the sludge are usually dreading or sand covering. Dredging is a simple way and aims to cut off the sludge. But after cutting off, treating the dredged sludge takes much more time and, of course, cost. Sand covering, in general, gives a big load to living organisms and the ecological system. Here, a more efficient way is needed to reduce the sludge while not imparting environmental load in the local sea area. [1]

Now, we have micro-bubble technology. [2], [3], [4] Micro-bubbles can change conditions into an aerobic state. [5] If the bubbling stops, the situation changes into anaerobic state, according to recent research. [6] So, we selected a method by using of microorganisms for decomposing the sludge.

Therefore, our research targets a purification system on oceanic sedimentary sludge by microorganism activator after the aerobic state was made by micro-bubbles. In this paper, we investigate the capability for the purification system on circulating type, by comparing with the water temperature, the density of activator and the circulation velocity.

2. EXPERIMENTAL SYSTEM

2.1 Experimental Apparatus

The experimental devices consist of two parts, shown in Fig. 1 and 2. The water circulates through two tanks. One tank generates micro-bubbles. The micro-bubbles have micro size diameter and high solubility. The other part is the experimental tank. The sludge is put in this tank. The two tanks are separated due to the high flow velocity created by the bubble generating pump.

We used sludge sampled from the ocean, as shown in Fig 3. Here, seawater and ocean sludge were picked up from Funabashi Port in Tokyo in Japan, as shown in Fig.3 and 4.

Microorganism activator is used; this is liquid and mainly comprises Kelp and also includes nutrients and some enzymes. Our used activator is reported to show effective results in purification for grease trap.

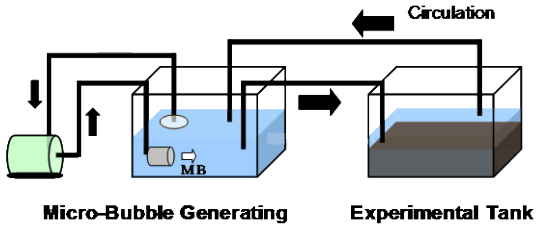

Fig. 1 Experimental Devices

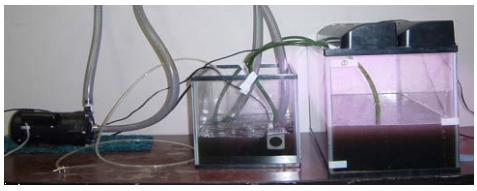

Fig. 2 Experimental Devices

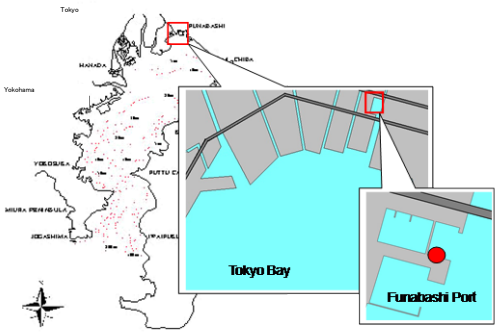

Fig.3 Catching Point of Sludge at Funabashi Port in Tokyo Bay

Fig.4 Catching Sludge

2.2 Experimental Procedure

At first, the sludge is put in the tank and the micro-bubble device is powered on. After 6 hours, the microorganism activator is put in the tank. The measurement items are dissolved oxygen (DO), water temperature, pH, hydrogen sulfide (H_2S), total nitrogen (T-N) and total phosphorus (T-P). In Case 8, only the micro bubble device was operated. Experimental conditions are shown in Table 1.

Table 1 Experimental Conditions

Case	Room Temp. (degree)	Density of Activator (ppm)	Circulation Velocity (cm/s)
①	20	100	0.6
②	23	100	0.6
③	20	200	0.6
④	30	200	0.6
⑤	20	200	5
⑥	20	200	8.4
⑦	20	200	10.7
⑧	20	0	0.6

3. EXPERIMENTAL RESULTS

3.1 DO, Water Temperature and pH as Conditions for this Experimental

Measured results of water temperature, pH and DO in all experimental cases are shown in Fig.4 to Fig.6, respectively. Water temperature up to 12 hours increased rapidly, and then became constant between 25 and 30 centigrade. It seems this was caused by the heat from friction of the micro-bubble device. pH up to 6 hours increased a little and then became constant. The constant value was 8.0 to 8.6. Dissolved oxygen up to 6 hours increased a little and then became constant. It seems oxygen dissolved and reached the saturation point. From these results, we can recognize anaerobic state changing into aerobic state.

It seems that these results are very good conditions for growth of microorganisms.

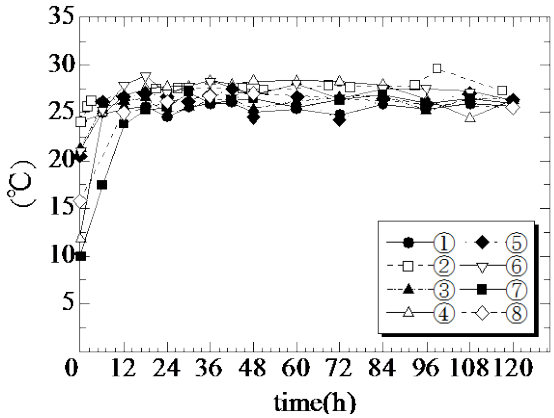

Fig. 4 Changes in water Temperature

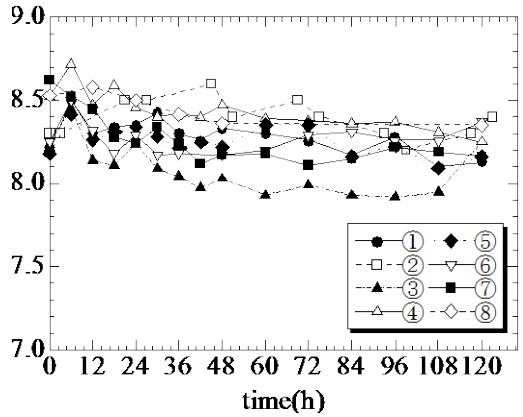

Fig. 5 Changes in pH

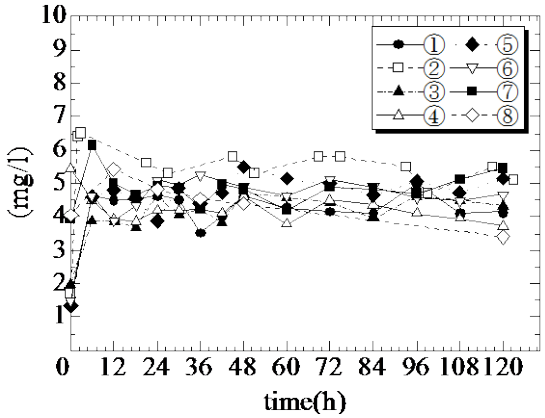

Fig. 6 Changes in DO

3.2 Effects on Activator of Microorganisms

Checking the mechanism in this experimental system, the density of sulfate was analyzed. Comparing with the effects on activator of microorganism, experimental conditions are shown in Table 2.

The density of sulfate is shown in Fig. 7. The result was obtained by the iron chromatography. The slope of the density of sulfate in Case 7 is bigger than the one in Case 3. But the slope in Case 8 is almost no change or less. It seems that sulfate increases due to the activity of sulfur bacteria. It also seems sulfate increases according to the circulation velocity. On the other hand, there is no effect in Case 8 for only bubbling.

The content of sulfur is shown in Fig. 8. This result was obtained by the elementary analysis. These are normalized expression divided by the initial value at time=0. The initial values are 3.18, 1.66 and 1.66 in the order of Case 3, 7, 8.

Especially in Case 3, the content of sulfur up to 6 hours did not change but after 6 hours it decreased rapidly, since the activator of microorganisms was put in the experimental tank after 6 hours. It seems that microorganisms changed the sludge into the sulfur.

This is similar in Case 8 which is only bubbling. But we cannot see the same thing in Case 7 in which circulation velocity is fast, and also the values decrease.

Table 2 Experimental condition for checking the mechanism

Case	Room Temp. (degree)	Density of Activator (ppm)	Circulation Velocity (cm/s)
③	20	200	0.6
⑦	20	200	10.7
⑧	20	0	0.6

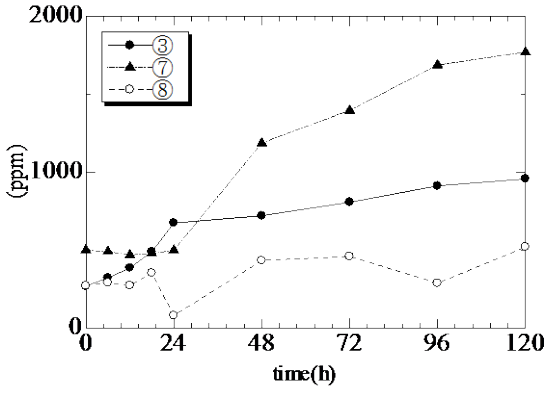

Fig. 7 Result of density of sulfate

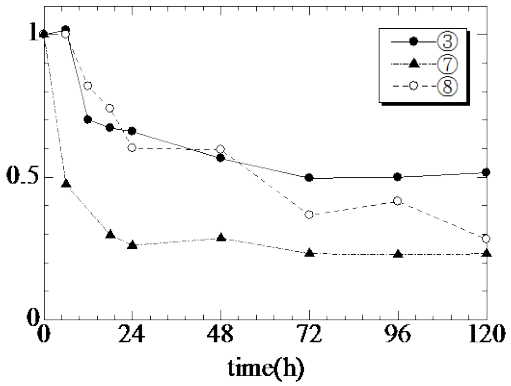

Fig. 8 Result of content of sulfur

3.3 Effects on Purification in Relation to Water Temperature

We checked the effects of purification in relation to the water temperature. Comparing with the water temperature, experimental conditions are shown in Table 3. When the density of activator is 100 (ppm), Case 1 and Case 2 are shown. When the density of activator is 200 (ppm), Case 3 and Case 4 are shown. Case 8 is only bubbling by the micro-bubble device. The H_2S is shown in Fig.9, and also the reduction speed of H_2S in Fig.10.

When the density of activator was 100 (ppm), comparing with Case 1 and Case 2, the reduction speeds of H_2S in Case 1 was faster than in Case 2, and then the average water temperature in Case 1 was 25.1 degrees centigrade.

When the density of activator was 200 (ppm), comparing with Case 3 and Case 4, the reduction speeds of H_2S in Case 3 were faster than in Case 4, and then the average water temperature in Case 3 was 25.7 degrees centigrade.

Therefore, the reduction speed of H_2S is more effective at water temperature of about 25.0 degrees centigrade, but purification at over 25.0 degrees centigrade takes a little longer.

Moreover, H_2S except in Case 8 was reduced to the lower limit for measurement within 24 hours. H_2S in only bubbling case in Case 8 took a little longer.

Table.3 Experimental condition for purification effect in relation to water temperature

Case	Room Temp. (degree)	Density of Activator (ppm)	Circulation Velocity (cm/s)
①	20	100	0.6
②	23	100	0.6
③	20	200	0.6
④	30	200	0.6
⑧	20	0	0.6

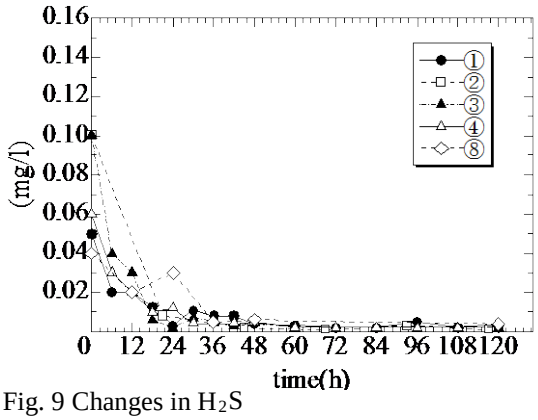

Fig. 9 Changes in H_2S

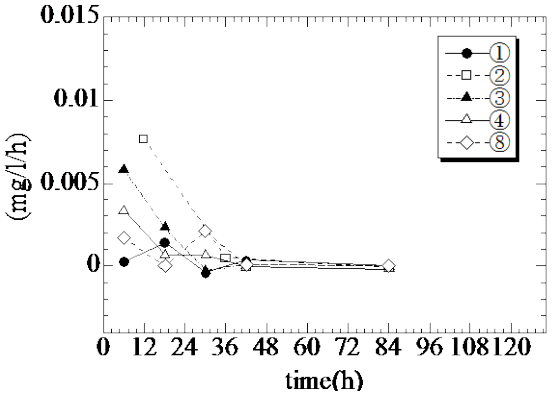

Fig. 10 Changes in speed of H_2S

Measured results of T-N and T-P are shown in Fig. 11 and 12, respectively. T-N has tendency of decreasing. Reduction ratio of T-N has no differences among all cases. T-P has also no difference among all cases. Here, water temperature does not influence the reduction ratio on T-N and T-P.

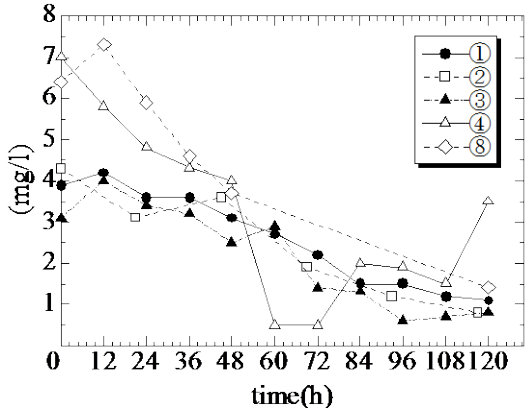

Fig. 11 Changes in T-N

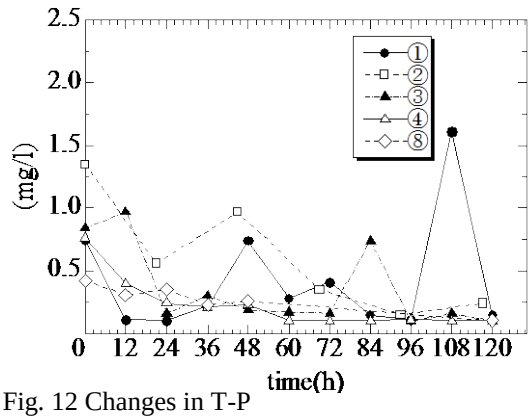

Fig. 12 Changes in T-P

3.4 Effects of Purification in Relation to Water Temperature

We checked the effects of purification in relation to the circulation velocity. Comparing with the circulation velocity, experimental conditions are shown in Table 4. Measured results of H_2S are shown in Fig.13 and also the reduction speed of H_2S in Fig.14. The reduction speed in Case 7 was faster than in the other cases. When the circulation speed became faster, reduction speed became faster. However, we could not clarify the maximum circulation speed for suitable purification. Moreover, reduction of H_2S in the case of bubbling only in Case 8 took a little longer.

Measured results of T-N and T-P are shown in Fig. 15 and 16, respectively. T-N in all cases decreased. Reduction speed of T-N in Case 7 was almost the same or a little faster. This was caused by the high initial value of Case 7. T-P in all cases decreased. The circulation speed does not influence the reduction of T-N and T-P. T-P in Cases 3, 5 and 6 increased from 0 to 24 hours, but it did not increase in Cases 7 and 8.

It is assumed the circulation velocity in Case 7 was too fast to allow microorganisms to grow.

Table 4 Experimental condition for purification effect in relation to circulation velocity

Case	Room Temp. (degree)	Density of Activator (ppm)	Circulation Velocity (cm/s)
③	20	200	0.6
⑤	20	200	5
⑥	20	200	8.4
⑦	20	200	10.7
⑧	20	0	0.6

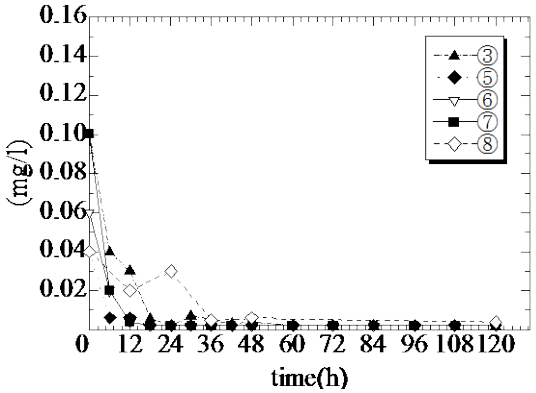

Fig.13 Changes in H_2S

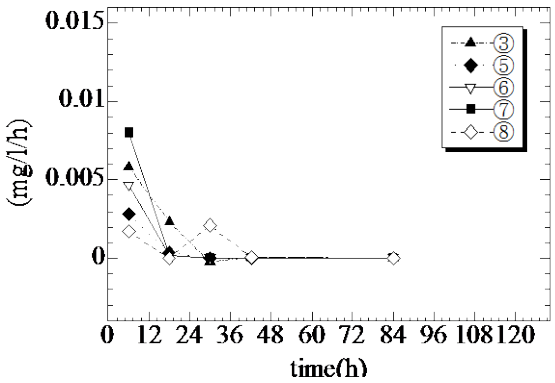

Fig.14 Changes in speed of H_2S

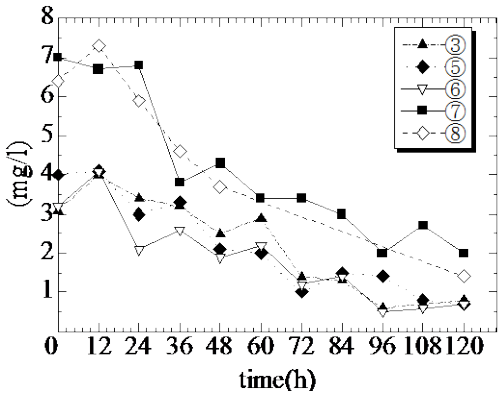

Fig.15 Changes in T-N

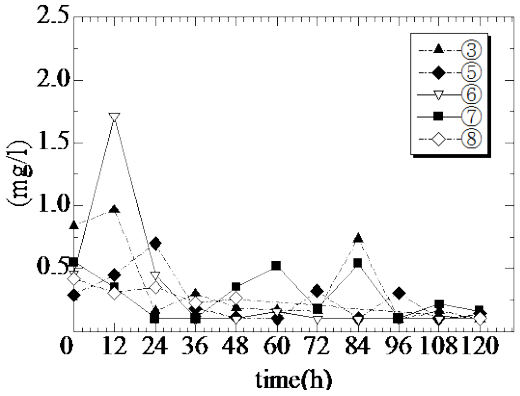

Fig.16 Changes in T-P

4. CONCLUSION

We carried out purification experiments on oceanic sedimentary sludge, using of purification system on circulating type by micro-bubbles and microorganism activator.

As a result, our system could purify the sludge up to 120 hours by microorganism activation. Our system could reduce the hydrogen sulfide in the sludge to the lower limit for measurement within 24 hours.

5. ACKNOWLEDGEMENTS

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