The Seawater Purification Method by Effective Microbe

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1. INTRODUCTION

The purpose of this study is to investigate the new biological method that improves the quality of enclosed seawater. The performance of the rock bed contact-purification method has been investigated[1)] and it has been found that it is difficult to remove Dissolved Organic Carbon (DOC). It was verified that Dissolved Organic Carbon (DOC) in sea water was refractory and stable[2)]. Furthermore, bacteria which could effectively degrade refractory DOC was sought[2)]. The most effective degrader was *Pseudomonas paucimobilis*[1)]. *P.paucimobilis* mixed with naturally grown microbes at a ratio of 10% degraded DOC 2-3 times as much as *P.paucimobilis* did by itself[2)]. We tried to put the effective microbe, *P.paucimobilis* , to practical use in the rock bed contact-purification method. This study was examined as follows ; immobilization on a rock bed, survival in a coastal environment, DOC degradation activity of the rock bed with *P.paucimobilis* and performance of the original rock bed contact-purification plant with *P.paucimobilis* .

2. MATERIALS AND METHODS

Immobilization of P.paucimobilis

The characteristics of *P.paucimobilis* attaching to gravel were examined. *P.paucimobilis* was added to the experimental flume (W100 x L500 x H80 mm) which was filled with gravel (d10mm) and filtered seawater without suspended solids (SS). The gravel was picked on the coast and was not sterilized before the experiment. The initial number of *P.paucimobilis* in the flume was approximately 10^4 CFU/ml. The number of attached and free *P.paucimobilis* was counted for 50 hours.

Survival of attached P.paucimobilis in the coastal environment

After immobilization of *P.paucimobilis* , the gravel was left in the shore for 90 days and the number of attached *P.paucimobilis* was counted every few days.

The experimental plant and the rock bed

Two original experimental plants (W3514 x L1800 x H3300 mm) were set up at Komatsushima harbor, Tokushima, Japan in July 1995. Ordinary Concrete (OC) and No-Fines Concrete (NFC), also known as Porous Concrete, were used as the rock bed respectively. One plant was filled with OC (OC plant) and the other was done with NFC (NFC plant). SS was physically removed by a concrete and DOC was bio-degradated by the biofilm on a concrete. SS removal, DOC degradation and attached bacteria number of both concretes were compared. The size of NFC and OC was the

same, d150 x 300 mm.

DOC degradation by the rock bed immobilized P.paucimobilis

The concretes were taken out after 2 months and *P.paucimobilis* was attached. DOC degradation activity of both concretes with *P.paucimobilis* was examined at 20 °C in a dark room in the water way. Initial DOC was 5.0 mg/l, pH 8.0 and p.s.u. 30. The velocity of flow was smaller than that at the flood tide and was 2 times as much as that at the ebb tide. The water purification experiment using NFC with *P.paucimobilis* also conducted in the plant.

3. RESULTS AND DISCUSSION

Immobilization of P.paucimobilis

Figure 1 shows the variation of the number of free and attached *P.paucimobilis* to gravel. *P.paucimobilis* attached to gravel within 3 hours after the beginning. The number of both bacteria was stable for 50 hours. These results indicate that *P.paucimobilis* could attach to gravel in the short term .

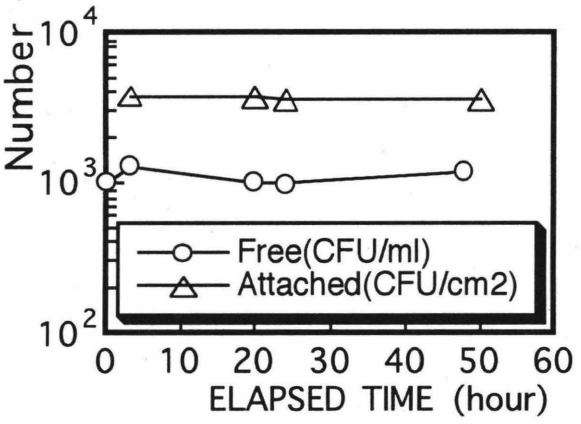

Fig.1 *P.paucimobilis* number

Survival in the coastal environment

Figure 2 shows the number of attached *P.paucimobilis* and other bacteria to gravel left in the coast. Although decreasing slightly during 14 days, the number of *P.paucimobilis* was stable for 90 days. The ratio of *P.paucimobilis* to naturally grown microbes was 20-50 %. It was found from previous experiments, that if the ratio is above 10%, the activity of DOC degradation will be effective. Therefore the ratio of 20-50% is suitable for effective DOC degradation. This finding shows that *P.paucimobilis* was not selected or exfoliated for several months even in the coastal environment.

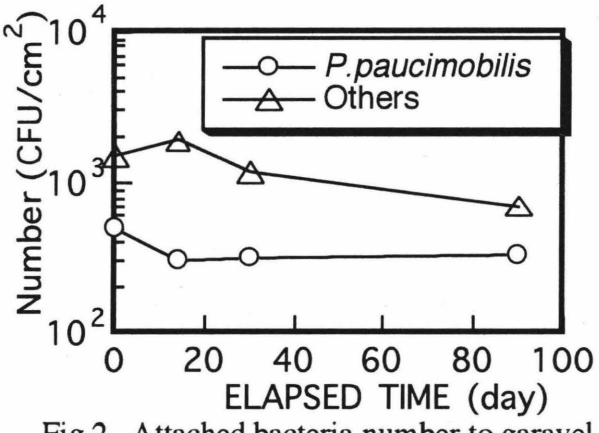

Fig.2 Attached bacteria number to garavel in the coast

DOC Degradation of attached P.paucimobilis

Figure 3 shows the variation of DOC

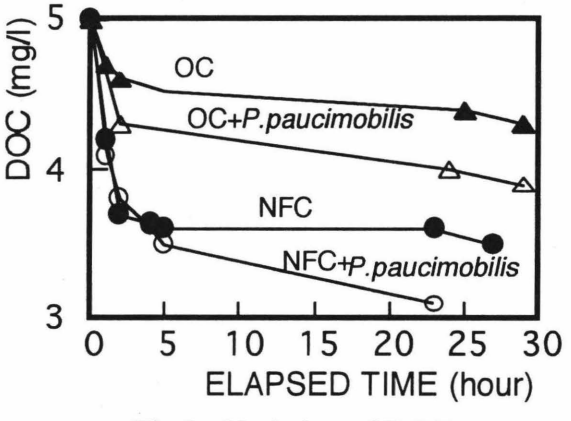

Fig.3 Variation of DOC

in the water channel. Four kinds of water purification carriers were respectively used as follows ; OC, NFC, OC attached *P.paucimobilis* (OC+*P.paucimobilis*) and NFC attached *P.paucimobilis* (NFC+*P.paucimobilis*). Comparing the results in the ratio of DOC removal at 23 hours, 12%, 26%, 19% and 37% of initial DOC in seawater was removed by OC, NFC, OC+*P.paucimobilis* and NFC+ *P.paucimobilis* . The DOC degradation activity of NFC was 2.2 times as much as that of OC. In attaching *P.paucimobilis* to NFC, the degradation activity became 1.4 times as much as NFC did by itself. This finding shows that, from a practical point of view, using NFC+ *P.paucimobilis* as a water purification carrier is effective in purifying seawater.

Performance of the Experimental Plant by using P.paucimobilis

Performance of the experimental plant was investigated before the examination of the utilization of *P.paucimobilis* . The average amounts of removed SS and the removal ratio of SS per a plant in a year were 7.0 g/day, 22.7% by NFC plant and 5.5 g/day, 9.9% by OC plant. In September, the attached aerobic and anaerobic bacteria numbers were $10^{8.3}$ and $10^{7.8}$ CFU in a piece of NFC. The attached aerobic and anaerobic bacteria numbers were $10^{7.4}$ and $10^{7.2}$ CFU in a piece of OC. Both attached bacteria number were not remarkably varied and throughout one year the number of bacteria in NFC was larger than in OC. Comparing the degradation activity of DOC of both plants in September, the average amount of removed DOC by NFC plant was 2.1 times, 2.8 g/day, greater than in OC plant. It was confirmed that the plant with NFC as the rock bed was superior in removing SS and DOC.

Plant experiments with NFC+*P.paucimobilis* were performed. The amount of removed DOC per piece of NFC was 4.5 mg/day. Attaching *P.paucimobilis* to NFC, the activity of DOC degradation improved to 1.4 times. This was consistent with the former experimental results. Comparing the performance of this plant with that of a sandy beach[3], the amount of removed DOC by the plant with NFC+*P.paucimobilis* corresponds to 21 - 26% of that by a sandy beach per unit width.

These finding show that it is possible to degrade DOC effectively by the rock bed contact-purification method, if NFC+*P.paucimobilis* is used as a rock bed.

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