Waterkeeper, 신규효소에 의한 수권생태계의 개선

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Improvement of Aquatic Sphere by a Novel Enzyme, Waterkeeper

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Introduction

"Waterkeeper"is an enzyme (i.e., catalyst) which has a capability to activate microorganisms living in the environment, mainly aquatic ecosystems, and was made from a complex of the bromeline enzyme superior to anti-oxidation and anti-bacterium functions by an original technology of Minaki Advance Co., Ltd., Japan. Besides, Waterkeeper can control or suppress the growth of corruptive and miscellaneous bacteria in polluted surface waters and sludge by its anti-oxidation and anti-bacterium functions, and accordingly, can selectively activate the microorganisms which are useful for the decomposition of organic materials. Waterkeeper is so-called a selective enzymatic catalyst for effective microorganisms, i.e., selective catalyst.

The main components of Waterkeeper are (1) Bromeline possessing anti-oxidation and anti-bacterium functions, (2) Vitamin B group functioning as the co-enzyme, (3) Fermentation-reduced modified yeast which especially enhances the decomposition of sedimentary sludge, (4) Citric acid possessing functions of energy source to aerobic bacteria and anti-oxidation. Based on the numerous field test results on the continuous addition of Waterkeeper to the polluted water area, the following phenomena appear in sequence after its continuous addition. ① Odors are eliminated. ② CH_4 bubbles are generated, and spread over the entire surface of water. ③ N_2 bubbles generated by the denitrification spread over the entire surface of water. ④ Sludge decomposition starts. Flocculated sludge is observed on the surface of water. ⑤Sulfides and other toxic substances are decomposed. ⑥ Fish, crab, turbiflex worms and other inhabitants return, and exist. ⑦ COD, BOD, SS, T-N, T-P and so on are improved, and other pollutants are decomposed and reduced. ⑧ The ecosystem is recovered, i.e. algae required for spawning grounds, are recovered. In the present work, improvement stages of water quality by the continuous addition of Waterkeeper into a typical aquatic sphere will be outlined.

Typical water-polluted area － Before the addition of Waterkeeper (see Figure 1)

Oxygen in the atmospheric sphere is absorbed into surface water to result in the formation of aerobic region. The width (i.e., the depth from the surface of water area) of the aerobic region is reduced, depending upon the degree of water pollution. For the dissolved oxygen (DO) is more consumed by microorganisms which decompose organic materials, as the degree of pollution is increased. Under the aerobic condition, the organic materials are completely oxidized to produce CO_2, nitrate (NO_3^-), phosphate (PO_4^{3-}) and sulfate (SO_4^{2-}) apparently by reaction (2). If nitrogen is not oxidized to NO_3^-, ammonia is generated through reaction (3). If NO_3^- exists at DO≒0, the denitrifying bacteria decompose organic materials using NO_3^- as the H acceptor to produce nitrous oxide (N_2O)and N_2 (denitrification).

Both the aquatic sphere lying under the aerobic region and the deposited sludge are in an anaerobic state, where the organic materials which have not decomposed in the aerobic region, are decomposed to produce carbon dioxide (CO_2), methane (CH_4), ammonia (NH_3) and hydrogen sulfide (H_2S). Ammonia and hydrogen sulfide among these are bad odor gases. In the highly polluted area, the sunlight can not reach the anaerobic area because of its turbidity. Accordingly, phototrophic bacteria, green sulfur bacteria and purple sulfur bacteria, can not take place the photosynthesis. Thereby, hydrogen sulfide as the electron donor is not consumed through the photosynthesis. Hydrogen sulfide as well as ammonia generating in the anaerobic area result in diffusion into the aerobic region in what they are. If nitrifying bacteria and *thiobacillus thiooxidans* live in the aerobic region, ammonia and hydrogen sulfide will be converted to nitrate and sulfate, respectively. However, they are not so numerous and active, because the width of the aerobic region is reduced. Therefore, both ammonia and hydrogen sulfide result in evolution into the atmospheric sphere without reducing their concentrations. Methane generated in the anaerobic area tends to evolve into the atmospheric sphere in what it is.

Improvement stage Ⅰ of water quality accompanied by the continuous addition of Waterkeeper termed Phase 1 (see Figure 2)

When Waterkeeper is continuously added to the aquatic area to adjust the concentration there at 8 ppm, both the activation of effective microorganisms (catalysis) and the deactivation of bacteria leading to the putrefaction and contamination (negative catalysis) are caused owing to Waterkeeper's synergism of ① through ④. The activation of bacteria for decomposing organic materials (organics-decomposing bacteria), nitrifying bacteria, *thiobacillus thiooxidans*, denitrifying bacteria, etc. tend to induce complete decomposition of organic materials, conversion of ammonia and hydrogen sulfide to nitrate and sulfate, respectively, generation of N_2 and N_2O, etc. Accordingly, the turbidity in the aerobic region is reduced. Besides, Waterkeeper can activate organics-decomposing bacteria and phototrophic bacteria such as green sulfur bacteria, purple sulfur bacteria and purple non-sulfur bacteria living in the anaerobic area. Both green sulfur bacteria and purple sulfur bacteria begin to take place the photosynthesis to consume hydrogen sulfide (as the electron donor). The purple non-sulfur bacteria also begin to take place the photosynthesis to consume organic materials (as the electron donor). The decomposition of sedimentary sludge is promoted as well through the synergism of organics-decomposing anaerobic bacteria and fermentation-reduced modified yeast, and lumps of sedimentary sludge begin to float. The increase in the amount of DO which is consumed by effective aerobic bacteria activated by Waterkeeper, can be compensated by the decrease in that of DO which is consumed by bacteria leading to the putrefaction and contamination. It should be noted that the turbidity in the aquatic sphere keeps on diminishing, even though the increase in effective aerobic bacteria results in a lot of consumption of DO and a temporary reduction of the aerobic region.

Improvement stage Ⅱ of water quality accompanied by the continuous addition of Waterkeeper termed Phase 2 (see Figure 3)

Both the activation of effective microorganisms living in both aerobic and anaerobic areas and the deactivation of bacteria leading to the putrefaction and contamination are promoted more by the continuous addition of Waterkeeper. The complete decomposition of organic materials is enhanced. Thereby, the aerobic region is expanded and at the same time, the turbidity are reduced more. Accordingly, the activity of phototrophic bacteria in the anaerobic area is increased more, leading to the promotion of hydrogen sulfide consumption and organic material decomposition. At this stage, the concentrations of ammonia and hydrogen sulfide evolving into the atmospheric sphere markedly decrease enough not to feel bad odor. The evolution of methane still continues, and nitrogen gas bubbles are vigorously generated through the denitrification. The decomposition of sedimentary sludge is promoted more, and thereby the floatation of lumps of decomposed sludge is observed frequently. At the latter half of this phase, algae begin to live in the aerobic region, and through the oxygenic photosynthesis taking place in algae, oxygen gas is generated and the DO level markedly rises.

Improvement stage Ⅲ of water quality accompanied by the continuous addition of Waterkeeper termed Phase 3 (see Figure 4)

In order to maintain a favorable aerobic state, Waterkeeper must be continuously added to the aquatic area to adjust the concentration there at a level of 3 to 8 ppm, depending on the degree of imposed load. At this stage, the aquatic system is in a state where the activity of effective microorganisms is improved more and the bacteria leading to the putrefaction and contamination are restricted more. The growth of algae is promoted, and through the oxygenic photosynthesis (i.e., generation of oxygen) taking place there, the DO level is increased more. Thereby, organic compounds can be completely decomposed, and the turbidity markedly decreases. The sedimentary sludge gradually decreases. The sedimentary sludge is in a state of aerobe - anaerobe coexistence, but even if ammonia and hydrogen sulfide are generated under the anaerobic condition, they can be converted to odorless nitrate and sulfate, respectively, by nitrifying bacteria and *thiobacillus thiooxidans* living in the aerobic area. As the sedimentary sludge decreases, the generation of methane is reduced and finally the sedimentary sludge disappears. Accordingly, any methane, ammonia and hydrogen sulfide are not generated at all. The natural ecosystem is recovered, and as a result, aquatic organisms return and exist.

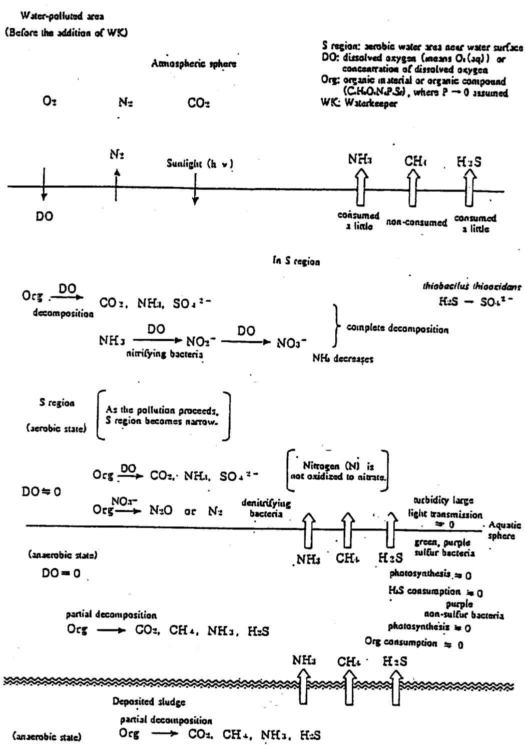

Figure 1 Typical water-polluted area
— Before the addition of Waterkeeper.

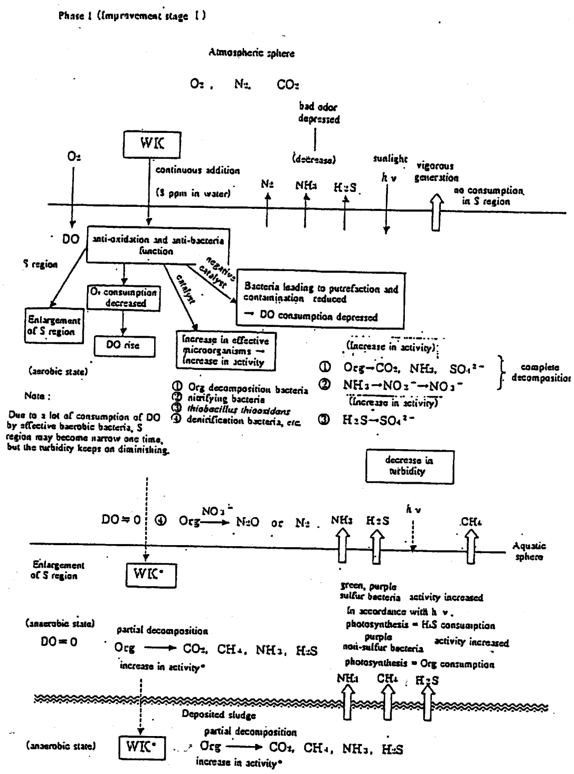

Figure 2 Improvement stage Ⅰ of water quality accompanied by the continuous addition of Water keeper.

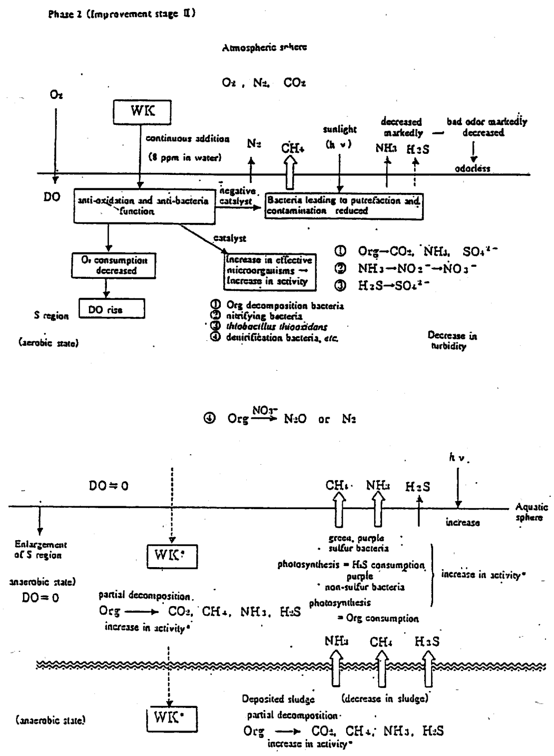

Figure 3 Improvement stage Ⅱ of water quality accompanied by the continuous addition of Water keeper.

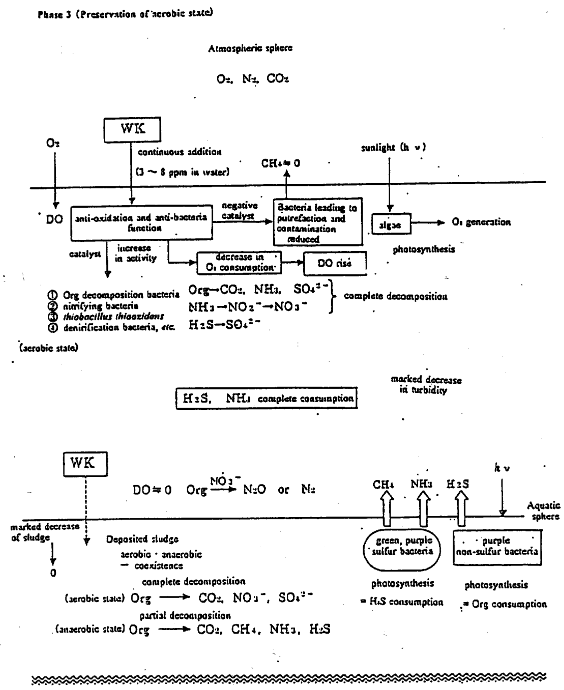

Figure 4 Improvement stage Ⅲ of water quality accompanied by the continuous addition of Water keeper.